Final Report

Taro East Landfill Expert Panel

October 2000

Preface

The Expert Panel has spent the last seven months carefully reviewing the voluminous information available on the Taro East Landfill. We have tried to meet with all key players, and to listen openly to what they told us. We have learned a great deal, and we have carefully and conscientiously recorded what we have learned in this report.

We would like to acknowledge the extraordinary efforts of Alison Collins, Researcher and Administrator of the Expert Panel, and to thank everyone who has helped us with our work. This includes members of the CLC, representatives of the Company and the MOE, and all of the people (including members of the public) who took the time to meet and share their views with us. We especially thank all concerned for their patience, as we took the necessary time to complete our report.

We hope that our report is read with the same open mindedness that we have tried to bring to the issues, and that all parties take the time necessary to read and understand the report and its implications.

In an undertaking of this magnitude there are bound to be a few factual errors, for which we apologize and take full responsibility. We would appreciate all parties' assistance in drawing our attention to any such errors.

It has been an honour to do this work. It is our sincere hope that our report offers a comprehensive explanation of the current situation, and that our recommendations offer a way forward on the issues which have caused such concern and which have been debated at such length over the past 5 years.

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Contents

Preface

1.0 Context 1

2.0 Background 3

3.0 Appointment of the Expert Panel 7

4.0 The Regulatory Regime 10

5.0 Definitions of Waste, Including Hazardous and Non-Hazardous 12

6.0 The Assumptions Behind Ontario's Landfill Regulations 14

7.0 Landfill Monitoring Issues 16

8.0 The Key Issues 17

- 8.1 What is in the Landfill? 17
  - 8.1.1 Landfill Sampling 19
- 8.2 Has the Site Been Well Engineered? 22
- 8.3 Is the Landfill Harmful to Human Health or the Ecosystem? 23
  - 8.3.1 Landfill Leachate Quality and Treatment Issues 24
  - 8.3.2 Leachate Quality and Quantity – Taro East and West Landfills 28
  - 8.3.3 Leachate Treatment Issues 29
  - 8.3.4 Summary of Recommendations 39
  - 8.3.5 Groundwater Impact Assessment 40
  - 8.3.6 Surface Water Impact Assessment 43
  - 8.3.7 Surface Water Impacts 43
  - 8.3.8 Recommendations Regarding Groundwater and Surface Water Issues 44
  - 8.3.9 Air Quality Issues 45
  - 8.3.10 Health Impacts and Implications 56
- 8.4 Are Appropriate Plans in Place to Ensure the Long Term Protection of Human Health and the Environment? 64
- 8.5 Are Sufficient Procedures in Place to Monitor the Landfill Operations on an Ongoing Basis? 64
  - 8.5.1 Financial Assurances 64
  - 8.5.2 The Role of CLC 65
- 8.6 Is MoE up to the Task of Protecting Public Health and Natural Environment? 68

9.0 Further Lessons from Taro 70

10.0 Conclusions 72

11.0 References 78

12.0 Appendices 81

List of Tables

Table 1: Leachate Characteristics: Expectations, Observations and Comparison to Hazardous Waste Leachate and Drinking Water Objectives 26

Table 2: Sewer Use By-law Limits and Other Objectives in mg/L 30

Table 3: Annual Average Particulate Concentrations ($\mu g/m^3$) 47

Table 4: Percent Exceedances of 24-hour Criteria 47

Table 5: Monitored Particulate Levels as % of Modelled Annual Average . . . 49

Table 6: Modelled and Monitored Particulate: Exceedances of 24-hour Criteria 49

List of Figures

Figure 1: Chloride Concentrations for West Landfill Leachate 31

Figure 2: Chloride Concentrations for East Landfill Leachate 34

Figure 3: Average Levels of Chloride Over Time at 2 Groundwater Monitors Downgradient of the Taro Landfills 42

Figure 4: Total Suspended Particulates – Annual Average Comparison 48

Figure 5: Total Suspended Particulates – Per cent Exceedences 48

Figure 6: Volatile Organic Compounds 54

Section 1.0

Context

The generation and disposal of waste is a significant problem of global proportions. In Canada, it is estimated that more than 4 million tonnes of construction, heavy industry, and hazardous by-products waste is generated yearly. Given the sheer volume of waste to be managed and the economic, spatial and environmental constraints posed by its management, landfilling remains the most common and economical means of waste disposal (Collins, 2000).

For both environmental and human health reasons, the best long-term solution to the waste problem in wealthy societies is to eliminate it entirely. There is no waste in nature. One creature's waste is another's food. By the end of this century, new industrial processes based on biomimicry (imitation of nature), pollution prevention, and "closed loop" production (in which wastes from production are recycled to become raw materials for further production) may indeed result in industrial waste reduction of between two and three orders of magnitude.[1] In the short and medium term, however, a large portion of the waste stream will continue to require landfilling.[2]

An entire business sector has grown up around the disposal of waste.[3] As this industry has become more sophisticated, concerns about the environmental and social impacts of waste disposal have attained greater prominence, and governments have paid more attention to the need for various forms of regulation to protect the public interest.

The public itself has also become more sophisticated and knowledgeable regarding landfill development and operation. Public concerns about the long-term impacts on human health and environmental quality typically surface in the pre-siting phase of landfill development and continue throughout landfill operation into the post-closure phase. Such public concerns are entirely understandable. No one likes living next to any industrial operation that could adversely affect the health of people or the natural environment. Vivid examples of environmental horror stories (e.g. Love Canal), and the recent movies "A Civil Action" and "Erin Brockovich," have added new metaphors to the discourse on waste. Here in Ontario, public concerns have been raised about the proposal to send waste by rail from the Greater Toronto Area (GTA) to a landfill near Kirkland Lake, which will be established in the abandoned Adams Mine. Closer to Stoney Creek, there has been considerable ongoing coverage in the Hamilton media concerning the costly cleanup of the Rennie and Ottawa Street landfills that are reported to be releasing toxic contaminants into the local (Redhill Creek) watershed.

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[1] See Paul Hawken Amory Lovins, and L. Hunter Lovins, Natural Capitalism: Creating the Next Industrial Revolution. Boston: Little Brown, 1999. The authors point out that "only one percent of the total North American materials flow ends up in, and is still being used within, products six months after their sale." (p. 81).

[2] European nations have made greater use of incineration technology and aggressive recycling and re-use programs. Germany has stringent "cradle to grave" legislation for packaging waste, and Sweden has been utilizing a sophisticated form of incineration which employs exceedingly high temperatures (pyrolosis) that enables Municipal Solid Waste (MSW) to act as an energy source for district heating and lighting. There are however limits to our current technology and environmental concerns regarding potential air pollution arising from incineration. Incineration and other 3R options do not eradicate the need for landfilling. Just as any "fire" leaves a residue, incineration creates a separate waste stream in the form of fly ash and bottom ash that still requires ultimate disposal (typically by landfilling). In fact, alternatives to landfilling are considered primarily as *volume reduction* processes, not disposal processes, due to the fact that they produce waste fractions which must be still ultimately landfilled (El-fadel et al., 1997).

[3] There is also a large and burgeoning academic literature in the natural sciences, engineering, and the social sciences that deals with all aspects of waste.

In order to address public concerns about the potential environmental and social impacts associated with their proposed sites, proponents of new landfill developments are required to undertake a process of community consultation. Under Ontario legislation, public hearings may also be required.

However thorough the pre-siting consultation process, when a new landfill is approved public concern often continues long after the question of siting has been resolved. In most instances, **ongoing** public involvement is mandated through a "public" or "citizen" liaison committee. In some cases, because of a "perceived lack of opportunity for meaningful participation" (Wakefield and Elliott, 2000), citizens may continue to fight the siting of a facility after the conclusion of the Environmental Assessment (EA) process.

Section 2.0

Background

In the early 1980s a small landfill began operations in the Taro West Quarry pit, located in the City of Stoney Creek about 1 kilometre south of the face of the Niagara Escarpment. This landfill was licensed to receive 100% non-hazardous industrial wastes generated within the Hamilton region. It was not intended as a destination for domestic household waste and, consequently, was never intended to function as a Municipal Solid Waste (MSW) disposal facility. Additionally, the Ministry of the Environment (MOE) imposed some site-specific criteria on the landfill that restricted waste to material that did not exceed twice the drinking water objective when subjected to a distilled water leach test. This requirement was placed on the waste to protect vegetation on the escarpment face that could be impacted by leachate (J. Percy, personal communication, September, 11, 2000).

Despite the fact that the substructure of the pit was fractured rock, which afforded very little natural protection, the West Quarry site (like most other landfills at the time) was not engineered to prevent the escape of leachate into the ground water.[4] When Philip Environmental Services took ownership of the operation in 1980, a plume of leachate had already begun to migrate off-site and impact surrounding groundwater. Steps were then taken to install wells to contain the leachate plume by pumping leachate and groundwater into a collection pond and then into the municipal sanitary sewer system.

During the construction and early operation of the West Landfill, there were relatively few people living nearby. By the end of the 1980s, however, new homes were being constructed in the vicinity of the landfill. The landfill operations were still sufficiently low profile that a number of the new residents were unaware of the existence of the landfill.

By 1988 it was clear that the West Landfill would soon reach its approved capacity.[5] Philip Environmental Inc. and Taro Aggregates Ltd. commenced preparatory work to obtain a Provisional Certificate of Approval[6] (PCA) under the Environmental Protection Act to permit landfilling in the East Quarry. This landfill would be fully engineered with a state of the art liner and additional hydraulic barrier system.

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[4] While this is troubling from an environmental perspective, the practice of depositing waste in a mined-out, unlined quarry was not unusual at the time. The management and containment of waste has undergone significant changes in both practice and technology in the last two decades. Trade and technical associations did not begin to develop and adopt appropriate landfill design and operation standards until the early to mid 1980s (Poland, 1991). The West Landfill facility was developed to the standard practices of its day.

[5] The West Landfill contained approximately 3,979,635 tonnes of waste in 1994, and was projected to meet its full capacity of 4,304,635 tonnes one year later. The original Certificate of Approval did not however specify a maximum capacity according to a "Staff Report" prepared by the Hamilton Region Conservation Authority, September 15, 1994.

[6] The terms Certificate of Approval (CofA) and Provisional Certificate of Approval (PCA) tend to be used interchangeably by MOE.

As with the development of any waste management facility, in order to gain approval for the proposed new landfill, the Company was required to complete an Environmental Assessment which included a number of sub-components. Engineering and hydrogeology experts were contracted to examine the feasibility of leachate containment. A health risk assessment was undertaken on behalf of the Company by CanTox, an Ontario based consulting firm. In addition the Company set up a "Study Group" consisting of seven local residents and several local officials.[7] The Study Group had their own lawyer and hired their own consultants (paid by the Company) to advise them on specific aspects of the EA. These independent consultants provided a peer review of the proposal for area residents (who were assumed to be represented by the Study Group).

The City of Stoney Creek also contracted a number of consultants to provide a peer review of the proposal on its behalf. In addition, the Regional Municipality of Hamilton-Wentworth, the Ministry of the Environment, the Hamilton Region Conservation Authority, and the Niagara Escarpment Commission conducted staff reviews.[8]

Meanwhile, a citizen group called Stoney Creek Residents Against Pollution (SCRAP) formed to organize local opposition to the landfill. The Chair of SCRAP was Brad Clark, who later won a by-election to become the local MPP. The activities of SCRAP received extensive coverage in the local *Stoney Creek News* through the writings of a reporter named Richard Leitner.

The initial focus of SCRAP was on the approvals process for the East Landfill application. The final decision whether to require a public hearing in connection with the Environmental Assessment of the application lay with the Minister of Environment, who at the time was Brenda Elliott. Recent changes in the EA process had affirmed the Minister's "absolute discretion" in making the decision whether to hold a hearing. MOE guidelines explain that even if the Minister "receives submissions requiring a hearing" in the course of the public review period, the Minister is authorized to decide to the contrary.

Ultimately the Minister exercised her discretion and in July 1996 approved the East Landfill application without a public hearing. Several individuals told the Expert Panel that, in their opinion, the decision of the Stoney Creek Council (on a narrow 5-4 vote) not to request a hearing probably weighed heavily in the Minister's decision. The decision not to hold a hearing was a great disappointment for SCRAP, but was welcomed by the Company, which had worked hard to obtain a negotiated settlement rather than having a public hearing.

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[7] "The Study Group consisted of eleven persons, seven volunteer residents of the local community, the Operations Manager for the City of Stoney Creek ,the Supervisor of Solid Waste Operations for the Region of Hamilton-Wentworth, the General Manager of Taro, and the Environmental Assessment Coordinator of Philip Environmental. The Study Group met generally once a month for two and a half years in public sessions and made important decisions about the assessment. Staff of the Ministry of Environment and Energy regularly attend as resource persons and we are grateful for their help." (first page of letter to the Minister January 26, 1995).

[8] Not all of these reviews recommended approval of the application. The NEC and HRCA were opposed to the landfill, based on concerns about its potential impacts on the environment. These concerns were addressed by the Company in a response provided to MOE.

Many who opposed the landfill felt angry and frustrated by the decision not to hold a public hearing. The study completed by Elliott and Wakefield (2000) reported that residents within Stoney Creek felt that they had only "perfunctory opportunities to get involved" and little opportunity to effect any real change or influence the process.

According to both media reports and comments several individuals made to the Panel, some opponents refused to accept the landfill and vowed to continue their opposition indefinitely in the hope that they could get the approval reversed and the landfill closed. Would their attitude have been different if they had had an opportunity, through a public hearing, to air their complaints and criticisms? Assuming the landfill had been approved anyhow, would these critics have withdrawn their opposition on the grounds that they had "had their day in court" and lost? Of course it is impossible to know.[9]

Would a public hearing have made more people aware of how the Company was planning to use the landfill? Some individuals told the Panel that they believe the answer to this question is yes. In the opinion of these critics, Philip never made it clear to the community that the Taro landfill would be the ultimate destination for wastes imported from outside the Hamilton-Wentworth "service area" for which it was licensed; or that some of the wastes destined for Taro were previously hazardous wastes that had been "stabilized" to render them non-hazardous[10].

The East Landfill began receiving wastes in December, 1996. One of the waste streams deposited in the landfill ignited a storm of controversy. "Filtercake" wastes (consisting of solid residues left over from the treatment of hazardous liquids) from a Philip-owned plant in Michigan called "CyanoKEM" were sent for processing to the Imperial Street Plant after first going to the Parkdale facility (all owned by Philip) which is licensed to receive waste from anywhere in Canada or the United States. Once these wastes were treated with other material at Parkdale, they were legally redefined as "local" wastes because Parkdale became the (local) "generator" even though the wastes had originated outside the province.

At Imperial St, the CyanoKEM wastes were treated through a process called "Ecosafe" which consists of stabilizing the waste by mixing it (using a front-end loader) with reagents (principally Portland cement). The resultant mixture (stabilized waste) passed the leachate toxicity test and was therefore legally suitable for deposition in a non-hazardous landfill. According to the Company's "best estimate," approximately 90,000 tonnes of stabilized or solidified waste was deposited in the East Landfill between December 1996 and September 1998.

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[9] There is however considerable support in the academic literature for this view. Citing several sources, Yacoumidis (1998) reports that "The failure to address and acknowledge the legitimacy of resident concerns during the siting/EA process tends to reinforce opposition to the landfill proposal…, and may leave residents feeling disempowered, resulting in higher levels of concern and cynicism… " The real (perhaps unanswerable) question is whether a public hearing would have been perceived as having acknowledged and addressed public concerns more effectively than did the numerous expert reviews of the proposal and the use of a "Study Group." A related question is whether the Study Group process might have been more effective had those who later became leaders of the opposition to the landfill been involved in the Study Group process.

On October 9, 1998, MOE sent a letter to the Company instructing them to cease depositing stabilized waste at the East Landfill pending further investigation. The letter further alleged that the Company was acting in violation of Regulation 347.[10],[11] The Ministry took this action in response to complaints received from a "citizen group"[12] that claimed that the waste manifests had been altered to disguise the hazardous nature of the waste once it had crossed the border.

The MOE referred the matter to the Investigations and Enforcement Branch (IEB). Meanwhile the CBC program *The Fifth Estate* broadcast a documentary alleging that the Company had illegally deposited hazardous waste in the landfill. A number of lawsuits were launched. In the end, the IEB investigator concluded that the Company had not violated Regulation 347 (and hence had done nothing illegal in its operation of the Taro East landfill). But public confidence was shaken, and both the Company and MOE were considered discredited by a segment of the community.

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[10] The implications of this allegation were quite severe. If convicted, the Company would have been liable for fines that could amount to hundreds of millions of dollars and possible prison sentences for senior officers.

[11] The EA documents did however indicate that one of the waste streams planned for the East Landfill was "stabilized waste."

[12] This group included Brad Clark, Michael Hilson, (a former Philip employee), Richard Leitner, Paul Palango (a free-lance journalist who was involved in helping produce a television documentary on Taro for the CBC's *Fifth Estate* program), and Tony Skarica (a local MPP).

Section 3.0

Appointment of the Expert Panel

In response to the public outcry, the Expert Panel was appointed by the Minister of Environment, the Honorable Tony Clement, on March 2, 2000. The decision to appoint such a panel was outlined in the MOE's "Six Point Action Plan" announced the previous September (see Appendix A)

The Panel's Terms of Reference (ToR) were developed by the Minister in consultation with the East Taro Community Liaison Committee (CLC). Several draft versions of the ToR were circulated for comment, including a draft prepared by the CLC. The final version was modified to limit the scope of the Panel's investigation to "existing documentation" and did not empower the Panel to gather new scientific data or conduct primary research.[13] The Panel's ToR are provided in Appendix B.

The Panel was given the mandate to comment on:

- potential long-term health impacts to the community related to waste disposal at the landfill;
- potential long-term environmental impacts related to waste disposal at the landfill; and
- the adequacy of existing measures to monitor, mitigate, prevent, reduce or otherwise control or assess impacts from the landfill on human health, air quality, ground water and surface water.

Although the Expert Panel was appointed by the Minister, the Terms of Reference explicitly required reporting to both the Minister and to the CLC, and instructed the Panel to provide the CLC with regular updates. Accordingly Progress Reports were given at CLC public meetings on May 17 and June 27. The Draft final report was to be sent to the Minister for review by the end of July, with the final version was to have been released to the CLC in late August.[14]

In appointing an "Expert Panel," the Minister deliberately chose not to establish a formal "Public Inquiry" under the terms of the Public Inquiries Act. Several local residents, and Philip Environmental Services, expressed disappointment that the Expert Panel would not be conducting a formal public inquiry in which evidence could be openly presented and challenged, and witnesses could be cross-examined. The Company in fact wrote to the Minister complaining that the Panel would be operating behind closed doors without benefit of input from the Company or other stakeholders, who would have no right to participate in the Panel's deliberations or to be privy to the testimony of other parties.

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[13] The Panel was authorized to recommend additional scientific data gathering if deemed necessary. In one earlier iteration of the ToR, there was a "13 point scoping list" which did include a provision for the panel to conduct its own scientific and/or technical investigations; however, MOE personnel indicated that time and budgetary constraints were the reasons behind limiting the scope of the Panel's TOR. All of the work that has been completed by the Expert Panel would have been required in any event in order to lay the basis for any further testing.

[14] This timetable proved overly ambitious and had to be adjusted. The Panel reported orally to the Minister in September, and released its Final Report in October.

Neither legislation nor formal guidelines exist for the conduct of a review of the sort that this Panel has undertaken. In theory, the Expert Panel could have chosen to operate in any fashion.[15] Early in its work, the Expert Panel made a commitment to be as open and transparent as possible. Notwithstanding the requirement to limit our investigation to "existing documentation," the Panel established direct contact (where possible) with the authors of relevant documents in order to expedite our understanding of the documents and to allow us to probe areas of ambiguity or gaps in the documentation made available to us.

The Panel made diligent and exhaustive efforts to obtain a comprehensive overview of the various issues related to the development, design and operation of the Taro East Landfill. Accordingly the Panel arranged a series of meetings/workshops with key stakeholders including the MOE, the Company and their consultants, health officials, the local conservation authority, representatives of local residents, the local media, and (through an invitation advertised in the local media) any member of the public who wished to meet the Panel privately to ask questions or express concerns. The Panel also visited the landfill and toured the Imperial St. processing facility. (A full list of meetings held and individuals contacted is included as Appendix C to this report.)

The key scientific and intellectual challenge for the Panel was to understand the complex issues related to the construction, operation, and decommissioning of the Taro East Landfill. The Panel members are experienced scientists and engineers who collectively provide a broad range of expertise on specific aspects and included **organic chemist** Otto Meresz Ph.D., P.Eng.; **health experts** Thomas Podor Ph.D. and Fran Scott M.D., M.Sc.; **landfill design expert** Kerry Rowe P.Eng., Ph.D., D.Eng.; **hydrogeologist** Wilf Ruland M.Sc.; **wastewater specialist** Joe Stephenson P.Eng., M.Eng.; and **air quality specialist** Antoon van der Vooren P.Eng., Ph.D.

Since the world is made up of complex wholes embedded in larger systems, and because the whole often exceeds the sum of its parts, the Expert Panel has tried to address the whole range of issues related to the Taro East landfill, including understanding the legal and regulatory context within which it operates. In this regard the Chair/facilitator's (David Bell Ph.D.) background in political science and the study of **environmental and sustainability policy** proved useful.

Throughout our investigations, Panel members have tried to make the results of our work comprehensible to a non-expert audience. This is particularly appropriate given that the whole Taro process has been driven by public concerns – which are often the concerns of non-experts.

In our first interim report we attempted to identify the key questions underlying that public concern:

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[15] The Terms of Reference did however encourage the Panel to operate in a "workshop" format (rather than simply having each panel member individually review documents related to his or her own area of expertise) in order to tap into the "collective wisdom" of the entire panel.

1. What is in the landfill?
2. Is it harmful to people?
3. Is it harmful to the non-human natural environment?
4. Has the site been well engineered?
5. Are sufficient procedures in place to monitor the landfill's operations on an ongoing basis?
6. Is the MOE up to the task of protecting public health and the natural environment?
7. Are appropriate plans in place to safely close the site at the end of its operation?

Earlier in the CyanoKEM controversy, many questioned whether the Company had broken any laws. As pointed out above, the Investigations and Enforcement Branch of MOE definitively answered this question following a thorough study. The investigator concluded that the Company had not in fact broken the laws of the Province of Ontario in its operation of the Taro East landfill. The Expert Panel accepts this conclusion.

The MOE investigation did however call into question the adequacy of some aspects of Ontario's laws and regulations respecting landfills. For example the "Guidelines for Waste Generators" did not have the force of law. Revisions to these regulations were proposed as part of MOE's Six Point Action Plan. These amendments to Regulation 347 now reference the Guidelines and provide them force of law.

The fact that MOE proceeded to act on the recommendation to tighten up the regulations had a paradoxical effect. It exacerbated the concern of those who were worried that harmful material went into the landfill as a result of a "loophole" in existing legislation, and fuelled the call for "core sampling" of the landfill to determine precisely what is in the landfill (Question 1 above).

At the same time, the decision to tighten regulations has undoubtedly shaken some people's confidence in the adequacy of other aspects of the existing legislation, and in the MOE's ability to protect the public and the natural environment (Question 6 above).

The resulting atmosphere of suspicion and distrust (likely made worse by the several lawsuits connected to this controversy) provided the impetus to the establishment of the Expert Panel. According to the Terms of Reference, the Expert Panel was to both "advise the Minister" and also "help rebuild public trust and confidence."

Section 4.0

The Regulatory Regime

All members of the Expert Panel have had to develop an understanding of the legislative and regulatory framework affecting landfills. Before discussing this arcane – but crucially important – topic, it is useful to look at how this regulatory framework has emerged in Ontario.

There have been laws dealing with various specific aspects of the natural environment since ancient times. Only recently, however, have governments regarded the environment as a whole as sufficiently important to warrant the creation of departments or ministries.

The world's first Ministry of Environment was established in Japan in 1969. Canada followed suit in 1970, Ontario in 1971. By the end of the 1970s a comprehensive framework of laws and regulations concerning waste and pollution was largely in place in most OECD countries. The most recent major change of this legislation in Ontario took place six years ago with the passage of the Environmental Bill of Rights. By the early 1990s, critics in both the public and the private sector had questioned the appropriateness of a regulatory approach based on what was called "the old system of command and control." The business community urged governments to adopt more "flexible" policy approaches such as economic instruments or voluntary measures. At the same time, governments were facing strong fiscal pressures to reduce the cost of their operations in order to stop the downward spiral of growing deficits and debt. These fiscal pressures were given ideological impetus by political parties that favored deregulation, downsizing and privatization.

In June 1995, Ontario voters elected the Conservative Party led by Mike Harris, who campaigned on a platform called the "Common Sense Revolution." The new Premier announced that Ontario was now "open for business."[16] He promised to cut red tape and get government (particularly the Environment Ministry) "out of the face" of business. Over the next two years, the budget of MOE was cut nearly 50% and the staff was reduced by more than 40%. The impact of these cuts on the capacity of MOE to serve the public interest in relation to the Taro operations was cited in print media coverage of the controversy.[17]

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[16] The Canadian Institute for Environmental Law and Policy (CIELAP) parodied this perspective by entitling their June 2000 report on toxic waste "Ontario: Open for Toxics." The subtitle announces the report's main message: "Hazardous waste disposal becomes a growth industry in Ontario."

[17] See for example the January 30, 1999 letter to the *Hamilton Spectator* from Stoney Creek resident Patrick Lynch, reacting to Brad Clark's announcement that he intended "to run as the Mike Harris candidate in Stoney Creek." Lynch asked, "Is that the same Mike Harris who has gutted the staff and budget of the environment ministry?"

Regulation of landfills is affected by several Ontario statutes. The most important of these is the Environmental Protection Act (EPA) which is intended to provide for the "protection and conservation of the natural environment." Part V of the EPA stipulates the requirement to obtain a Certificate of Approval in order to operate a waste disposal site. Each certificate outlines the specific conditions under which each particular waste disposal site must operate.[18]

But what counts as waste? What kinds of waste are there? What are the criteria that determine how a particular type of waste will be categorized? What specific provisions are made for disposing of the different types of waste? Most of these matters are not covered in detail in the legislation (i.e., the Environmental Protection Act). Instead they are detailed in the regulations and supporting guidance documents that allow government officials to put the laws into practice.

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[18] Thus in addition to the general regulations discussed below, each landfill is governed by additional requirements outlined in the CofA. There are few general policies or guidelines outlining what a CofA should contain.

Section 5.0

Definitions of Waste, Including Hazardous and Non-hazardous

An important function of the regulations is to define key concepts such as "hazardous waste."[19] The legal definition of hazardous waste is not identical to the common sense meaning of the term as it is used in everyday speech. In some respects the legal definition of hazardous waste is counter-intuitive. The battery that powers a wristwatch is positioned within a few millimeters of the owner's skin for long periods of time. Yet the battery contains materials that (in sufficient quantity) are classified as "hazardous waste."[20]

By the same token, waste that is classified as "non-hazardous" may and often does include substances that could be toxic or harmful if they were released to the environment in sufficient quantities without appropriate treatment or control. There are many "contaminants" contained in non-hazardous waste, including heavy metals, various chemicals, asbestos, etc. Landfill sites are engineered to receive these wastes and manage them and the effluents that result from their decomposition in such a way that the risk they pose to humans and the natural environment is reduced or eliminated entirely.

From the perspective of the general public, the highly specialized language and complicated definitions used by the MOE to classify various types of waste are often confusing. Differences between Ontario and Michigan regarding how hazardous waste is defined and regulated have deepened this confusion. In both jurisdictions, some types of waste are regarded as inherently hazardous.[21] These substances appear on a special list and are therefore referred to as "listed" or "designated" hazardous waste. (The Michigan list and the Ontario designations are not identical nor is the prescribed method of treating these particular hazardous wastes. Under Michigan law, any waste "derived from" a *listed* hazardous waste automatically *remains* a "listed" hazardous waste, and as such it remains hazardous no matter what process is used to add "reagents" or other substances to try to change its toxicity unless it is explicitly de-listed.")[22]

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[19] MOE. "Registration Guidance Manual for Generators of Liquid Industrial and Hazardous Wastes," April 1995, Fig. 1 " Waste Identification Flowchart," pg. 7.(Appendix I)

[20] Much of this kind of waste is thrown into the household garbage and ultimately disposed of in a municipal waste landfill. In this way, small quantities of what, in larger quantities, might be classified as hazardous wastes end up in municipal landfills, many of which are also licensed to receive the kind of industrial waste that goes to Taro East.

[21] When talking about "hazardous" waste we need to consider both the chemical form/composition and the amount. To be classified as hazardous, a chemical not only must have the potential to harm health or the environment but must also be in a form and quantity that could be released by a pathway where there could be harmful exposure to either people and/or the environment.

[22] Ontario also has delisting procedures and requirements which were developed in early 1990s and released in April 1994 as Guideline C-16, Hazardous Waste Categorization and Review, along with the Guidance Manual (Vols. A and B). The documents are available on website **ene.gov.on.ca** (Publications – Manuals and Guidelines – Part C-Waste – documents C-16 and C-16-1).

In Ontario, another category – "characteristic hazardous" – is applied to wastes that may or may not be sufficiently toxic to be considered hazardous. The characteristics of these wastes must be tested to determine their toxicity. One test performed for this purpose is called the leachate toxicity test. A sample of the waste in question is soaked in acidic water and the resulting liquid is tested for the presence of contaminating substances. If the results show sufficiently high levels of contamination, that waste is classified as hazardous.[23]

Ontario regulations allow for the possibility that some kinds of waste that test as hazardous (i.e., "leachate toxic waste") can be "stabilized" by being mixed with[24] stabilizing substances (such as Portland cement), which cause chemical changes in the waste. The waste is then re-tested. If the resultant mixture tests as non-hazardous, the "stabilized" waste can be deposited in a non-hazardous landfill such as the East Landfill.

Under Michigan law, any waste "derived from" a hazardous waste automatically becomes a "listed" hazardous waste, and as such it remains hazardous no matter what process is used to add "reagents" or other substances to try to change its toxicity unless it is explicitly de-listed (which requires an application to their regulators). Discrepancies between the laws of Ontario and Michigan contributed to a huge misunderstanding between the Company, the MOE, and the community. This was evident in the public and media's reaction to the reported change in manifesting of the CyanoKEM waste as the waste crossed the border from Michigan into Ontario. Some media reported that the Company, with the stroke of a pen, had transformed hazardous waste into non-hazardous waste. On the contrary, however, no subterfuge had occurred. The definition and classification of that particular waste stream were simply different in the two jurisdictions (Ontario and Michigan).[25]

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[23] A similar process is used in the United States, but an alternative chemical test – called TCLP or the Toxicity Characteristic Leaching Procedure – is employed there. This test also includes organic compounds. Ontario regulations will be changed (effective March 31 2001) to substitute the TCLP for the Leachate Extraction Procedure (LEP). This change also includes adding a "derived from" rule and expanding Schedule 4 to include 88 parameters.

[24] Regulation 347 was amended in September 1999 to clarify the **mixing rule**: a mixture of listed wastes will remain listed wastes unless de-listed (see EBR Registry Number: RA9E0005). Prior to September 1999, the mixing of a listed waste with other non-listed wastes made that waste mixture non-listed and therefore subject to less restrictive treatments.

[25] The panel has learned that Michigan regulations would have allowed Philip to dispose of the waste in a non-hazardous landfill within its borders if the Company had successfully applied to have the waste "de-listed." Because of the absence of a "derived from" rule in Ontario, the CyanoKEM filter cakes were not classified as listed hazardous, in Ontario.

Section 6.0

The Assumptions Behind Ontario's Landfill Regulations

The regulations and guidelines affecting landfills are lengthy, detailed, and complex. Without attempting a full summary of these, it is useful to outline briefly the framework of assumptions – the legislative paradigm – that applies to landfill sites in Ontario. This paradigm is standard across North America. It is guided by a combination of science and common sense.

One element of the paradigm relates to the way in which waste disposal sites must be constructed. Here the emphasis is on preventing landfill "leachate" (i.e., the liquid generated within a landfill due to infiltration of water from precipitation and other sources) from contaminating the groundwater or running off into the surface water. This requirement has become much more stringent in recent years. When the Taro West Landfill was opened in the 1980s, no such requirement existed.

A second element of the paradigm relates to what is allowed to go into the landfill. Depending on how well the site has been constructed, and the findings of the Environmental Assessment conducted prior to issuing a Certificate of Approval to operate the site, each landfill is allowed to receive a certain class or classes of waste. In order to ensure that each landfill receives only forms of waste for which it is permitted, there are procedures in place to document every load taken to modern landfill sites.[26]

This is applicable to both non-hazardous and hazardous industrial sites. Municipal Solid Waste (MSW) sites have less stringent record keeping as loads coming in on municipal waste trucks are deemed to be non-hazardous by their origin.

In many cases (including the Taro East landfill) there are also requirements that representative samples be taken from the various "waste streams" going into the landfill, and that these samples be tested to ensure that only those wastes which are permitted by its Certificate of Approval are being deposited into the landfill.

Nearly all of this testing is carried out by the operators of the landfill or waste processing plant rather than by the MOE. However, the MOE has always had the authority to take samples or conduct sampling. Taking samples is a normal part of the Ministry's work, and its Provincial Officers have extensive powers of inspection. In the context of routine monitoring at Taro, the CofA for the East Landfill requires the Company to take a minimum number of samples and places responsibility on the Company to receive and landfill only those materials allowed in its CofA.

Companies often take more samples than required by law to protect themselves. The MOE, traditionally, has not taken additional samples unless they have reason to believe that there is a problem with some material. Since the CyanoKEM allegations were first brought forward, the MOE conducted an audit of the Taro facilities and took more than 400 samples from waste loads, leachate, and air. (See section below on the Role of MOE.)

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[26] Another difference between Ontario and U.S regulations is that American law places an onus of responsibility on the "generator" of hazardous waste for the entire life cycle of the waste. Ontario regulations relieve the generator of responsibility once the waste has been received at another site.

Once material has been passed through the testing screen and the documentation screen and deposited in the landfill, the **regulatory focus shifts**. It is very important to understand this shift, and the assumptions implicit in it. Instead of studying systematically the composition of waste materials that are in the site[27] (which of course changes with each new load of material brought in), attention is focused entirely on **what is coming out of the landfill**. The assumption of course is that the material in the landfill will only create a problem to the extent that any of it escapes from the disposal site and gets into the air or water. Accordingly the regulations require regular monitoring of the leachate and the air and water surrounding the site, rather than what is in the landfill. (On this point Ontario and U.S. regulations are in agreement.) This has important implications regarding landfill sampling (or core drilling) discussed later.

The Expert Panel looked closely at how this paradigm has been applied to the operation of the Taro East Landfill. The Panel reviewed the site's construction and operations. The Panel also examined the paradigm itself, to determine if there are dangers to public health and/or the natural environment posed by the application of this paradigm.[28]

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[27] The specific controls over what goes into a landfill such as the East Landfill are based on scientific predictions about how it will behave. As a result, liquid wastes (which would increase contaminated leachate) are not allowed, nor are municipal solid wastes (which contain putrescible wastes and therefore would increase gas generation).

[28] After announcing the establishment of the Expert Panel, then Minister of the Environment Tony Clement stated "I want to assure the people of Stoney Creek that any deficiencies in the existing hazardous waste regulation will be corrected to protect the health and environment of Stoney Creek and all Ontarians."

Section 7.0

Landfill Monitoring Issues

The Panel has tried to put the Taro East Landfill data on water and air quality into context in several ways:

- In relation to the various "standards" that have been set by governments for exposure to the various substances that are going into the air or water
- In comparison with other similar sites (i.e., both landfills and quarries) and with other parts of the local Hamilton/Stoney Creek region.

An important complication affects any analysis of the East Landfill. Its location immediately adjacent to the West Landfill and the quarry makes it difficult to differentiate impacts and management issues. As pointed out, the West Landfill was constructed using construction practices of that time and consequently it did not have any engineered controls.[29] It has already been found to have a leachate migration problem. Thus any landfill related water problems in the area are caused by the West Landfill rather than the East Landfill.

Similarly, the quarrying operations produce dust (as does the capping operation on the West Landfill) that then mingles with whatever dust is emanating from the East Landfill site, complicating air quality findings and again making it difficult to trace the cause of any air quality issues, especially dust related ones. Are they from the quarry, from the West Landfill, or from the East Landfill?[30]

Although our terms of reference instruct the Panel to focus on the East Landfill, we have found that we cannot ignore the larger local system, which includes the West Landfill and the East Quarry. Moreover the local residents' focus is on reducing problems whatever their source. To them the fine distinction of which contaminants or nuisance effects are coming from which of the three Taro operations (the East Landfill, the West Landfill, or the East Quarry) is less relevant.

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[29] It has subsequently been retrofitted with a groundwater containment system and a gas interception system.

[30] Dust problems in the area could also result from increased traffic due to the redevelopment of Mud Street.

Section 8.0

The Key Issues

8.1 WHAT IS IN THE LANDFILL?

The Taro East Certificate of Approval (CofA No. A 181008) restricts the permissible waste stream to "solid, non-hazardous commercial, institutional and industrial waste including petroleum contaminated soils."[31] This includes "...solidified/stabilized industrial wastes; industrial slags...." The CofA also explicitly indicates that "No liquid industrial wastes, hazardous wastes as defined under Regulation 347, or putrescible waste shall be disposed of in the waste disposal fill area on the Site."

Waste meeting these requirements would be expected to be more readily manageable and less likely to have an adverse effect on a landfill barrier system than conventional municipal waste that contains putrescible waste. As noted elsewhere in this Report, however, the restriction on waste indicated above should not be taken to imply that the waste in the East Landfill is benign; the leachate generated from this waste could be expected to contaminate ground and surface water if it were allowed to escape and hence must be contained until the concentrations have reduced to levels that would not have a negative impact on the environment if they were released. The period of time required for this to happen is called the "contaminating lifespan."[32]

The CofA stipulates the kind of wastes the East Taro Landfill is licensed to receive. But what materials are actually in the landfill? Underlying this question is the public's concern that hazardous wastes may have been illegally deposited in the East Taro landfill without the knowledge of the MOE. This concern was given considerable credence in the report of Officer Gordon Robertson who conducted the investigation of the CyanoKEM issue on behalf of the Investigations and Enforcement Branch of MOE. Robertson's final recommendation is crucial to this discussion:

> The waste in the Taro East Quarry must be properly sampled to determine if hazardous waste is contained on site and appropriate action taken if such waste is found. There is a high potential for finding hazardous waste at the site as there is existing evidence that the Ecosafe treatment process does not render all portions of some of the processed batches completely homogeneous and nonhazardous.[33]

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[31] Taro East Quarry Environmental Assessment, Design and Operations Report, Gartner Lee Ltd., January 1995, p. 4.

[32] It is likely that the contaminating lifespan for this waste will be long. Taro's consultants estimate that "leachate must be controlled within the site for at least 300 years." Taro East Quarry Environmental Assessment, Design and Operations Report, Gartner Lee Ltd., January 1995, p. 24.

[33] "Taro East Quarry Waste Disposal Site. Report on Alleged Receipt of Hazardous Waste Generated by CyanoKEM Inc. of Detroit Michigan" (MOE, September 1999) p. 22. The MOE District Office has also identified inconsistencies in sample analysis of wastes processed through the EcoSafe process. It is not clear if those inconsistent results are a product of incomplete mixing, the nature of the waste, or some other

This recommendation contains a judgment about the efficacy of the "Ecosafe" process that will be addressed later in this Report. It also proposes that the landfill be sampled in order to determine whether or not hazardous waste is present. This statement provides a partial rationale for the demand by some individuals, including members of the CLC and the local media, for "core drilling" of the landfill.

Notwithstanding Officer Robertson's recommendation,[34] once wastes have been deposited in a landfill, analyzing samples obtained through excavations or deep core drilling can not be used to determine if these materials were of a hazardous nature when they were placed in the landfill. There are at least two reasons for this.

First, provisions in Regulation 347 exempt from the definition of hazardous wastes small quantities of materials that in larger quantities would be classified as hazardous. A Generator could include a small amount of material that in larger quantities would be classified as hazardous waste, and this could legally find its way into the landfill. Although the Panel has no evidence that this has happened in the case of East Taro landfill, if testing of the landfill did indicate that potentially hazardous materials were in fact present, there is no easy or reliable way of telling if these materials got into the landfill legally (under the small quantities exemption) or illegally (i.e., in violation of Regulation 347 and/or the CofA). It is however important to note that any such material would represent a small percentage of the total waste and it is unlikely that it would significantly impact the leachate quality or the health and safety of residents around the site.

The second reason that sampling cannot reveal whether hazardous waste has been illegally deposited stems from the fact that materials can change once they have been deposited in a landfill. From the moment of emplacement, some of the wastes undergo a series of chemical, physical and/or biological changes. In a few instances, materials that do not test hazardous at one time may test hazardous later on.[35]

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reason. One condition of the amended CofA for 52 Imperial Street requires a technical review of the EcoSafe process. That review is discussed below.

[34] Officer Robertson's report on the CyanoKEM issue criticized the MOE for failing to understand the implications of various aspects of landfill and waste regulations; but went on to recommend a procedure which itself has no apparent legal basis, or precedent, in Ontario or in the United States.

[35] This is what is believed to have happened to some wastes known as the "Robertson Whitehouse" wastes, that tested hazardous after being exposed to the air while awaiting clearance from MOE for deposition in the East Landfill. The initial tests conducted before suspected oxidation had set in indicated that the wastes were acceptable. Had the wastes been deposited immediately they would not have been exposed to the air and may never have "turned" hazardous. When the delayed test samples came back, the wastes were removed and sent to the Safety Kleen hazardous landfill in Lambton County.

This example illustrates the possibility of the formation of hazardous chemicals after wastes have been placed in the landfill. It should be noted that although possible, such chemical reactions do not occur frequently. The low energy environment of the landfill seriously limits the number and types of chemical reactions that can take place. Thus, it is impossible for toxic organic compounds like dioxins and PCBs to spontaneously appear in the landfill due to reactions within.

What takes place in a landfill are slow degradation reactions, chemical and biological. Examples include microbes turning PAHs, DDT, and PCBs (if present) into less toxic metabolites. Generally, the more degraded a material is the less toxic/hazardous it becomes. There are exceptions though. For example trichloroethylene (TCE) can degrade to vinyl chloride, and the product vinyl chloride (VC) is a much more

Modern landfill sites are designed and engineered to ensure that unpredicted changes that occur in the chemical compounds within the wastes do not pose a danger to human or ecosystem health. If some of the wastes at a well engineered site did change in chemical composition, the design safety features of the landfill would serve to prevent any negative impact on the environment or the health and safety of the public.

Again it is important to note that significant changes of this kind would ultimately produce changes in the leachate that would show up in the monitoring results. There is no evidence of this in the current leachate data. If, at some point in the future, monitoring results did show evidence of changes in waste characteristics, there would need to be a re-examination of leachate treatment but the natural environment and the health and safety of residents would be protected from impacts by the level of containment provided at this site by such design features as: the operation of the leachate collection system, the multiple liners, and the future, back-up, hydraulic containment incorporated into the East Landfill design and operations.

We wish to reaffirm that the CyanoKEM waste that went into the East Landfill was not defined as hazardous. Nor is there any indication in the leachate to this point that any of the materials deposited in the East Landfill were hazardous wastes. There is still some question as to whether the CyanoKEM waste would be classified as non-hazardous under the new regulatory regime. The amendments to Regulation 347 now incorporate a mixing rule, which says that if hazardous waste is mixed with any other, waste the mixture remains a hazardous waste. Once the regulations have been amended to also incorporate the "derived from" rule, CyanoKEM waste stream would be classified as "listed hazardous." In order to get permission to treat this waste with the Ecosafe process and deposit it in a non-hazardous landfill, the Company would have to get the certificate of approval for Ecosafe treatment reassessed. This reassessment would be equally as rigorous as a de-listing.[36]

8.1.1 Landfill Sampling

The panel has heard repeated requests for "deep core sampling" from some members of the public and the CLC. As explained above, landfill sampling can **not** be used to determine whether hazardous wastes (as defined by Regulation 347) were deposited in the landfill. The only way to determine if an individual load was hazardous (as defined by Regulation 347) is to have sampled the load before it went into the landfill.[37]

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harmful chemical than the original chemical. It should be noted that this type of reaction is the exception, not the rule. In the case of this example, for the Taro East Landfill since the concentrations of TCE are very low there will be negligible breakdown to VC (as is evident from the leachate and air quality data).

[36] As pointed out, these changes (to incorporate the "derived from" rule) will take effect March 31 2001. Note that in an "Addendum" to his report on CyanoKEM, Officer Robertson acknowledges that "based on a special permit or delisting…some of the filtercake waste could have qualified for further treatment in the United States which would have rendered it non-hazardous."

[37] There is extensive documentation, prepared in accordance with the Company's "Waste Acceptance Procedure", of all wastes deposited in the East Landfill since it began operations in December 1996.

Since the current regulatory paradigm is silent with respect to the issue of what is actually found in landfills, there are no guidelines suggesting how to go about sampling the landfill or interpreting the results. How many samples should be taken and at what spatial intervals? Are samples then to be combined to get an overall measure of the material in the landfill? Should the samples be analyzed for bulk chemical composition and then tested for leachate toxicity? How can one interpret the results? What would they be compared against? What actions should be taken once the results are obtained? None of these questions is answered in the current laws and regulations.[38]

There are both in Ontario and elsewhere in the world, extensive protocols and standards for the assessment of site contamination. These protocols were developed for the purpose of site remediation in areas to be put into public or private use (for example in former industrial sites). In these cases the sampling and analysis is directed at identifying "contamination" based on the measured bulk sample chemical concentrations. These results are then compared to specific standards which are also bulk concentration standards. These standards are developed for various levels of potential site use and are all based on possible exposure routes for the proposed site use. More stringent standards are set if the site is to be used for unrestricted use, such as residential development. In that case, exposure routes that are considered in the standards are soil ingestion, dermal contact with soil and contaminant uptake in home grown vegetables. It is important to note, that the assessment of risk associated with all of these routes is based on the bulk chemistry of the material.

None of these standards is applicable to a landfill. The entire purpose of the landfill is to isolate the materials from these possible types of exposure routes. Waste materials would be found in the site that do not meet the contaminated soil criteria. This is to be expected. If the waste did meet contaminated soil standards, it would be considered clean fill and would not require landfilling at all!

The types of analysis that are being requested as part of any "deep core drilling" are likely, through bulk analysis, to indicate that the waste materials are "contaminated" by any "contaminated" site standard. For example they might show "exceedances" of heavy metals and/or organics. It is important to note that the **incoming** wastes, at this and other landfills, would **also** have exceedances of these types of standards and that exceedances of these standards are **not** part of the definition of "hazardous waste".

Landfill sampling could be used to refine the EA predictions of waste and leachate quality and, in turn, to update the CanTox risk assessment.[39] In the Panel's view however, regular monitoring of the landfill leachate and air emissions (as discussed elsewhere in

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Starting in January 1998, MOE has had an on-site inspector with full access to this documentation, and the opportunity to take independent samples of individual waste shipments as noted above.

[38] Recognizing the possible implications for all other Ontario landfills of a decision to undertake core sampling of Taro, the Ontario Waste Management Association weighed into the debate on the side of the Company and others opposed to sampling. Officials from the MOE advised the Panel that the Ministry not agrees that sampling the landfill is not the appropriate means to monitor what is in the landfill. MOE experts believe instead that sampling the leachate is the best approach to monitoring.

[39] The Panel found no examples of the use of landfill sampling in risk assessment or epidemiological studies. In preparing its risk assessment model, CanTox sampled the incoming waste stream, not the waste in the West Landfill itself, in order to strengthen its predictions.)

this Report) will provide sufficient "early warning" of any leachate or air problems to allow appropriate action to be taken.

Enhanced analysis of leachate and air emissions can be even more effective. Accordingly, ***the Panel recommends that the Ministry of the Environment undertake a limited mass spectrometric study of the leachate from the Taro landfill and from 3 other industrial waste facilities for comparison. Leachate samples and emitted gas samples (cartridge) should be analysed by open scan mass spectrometry at high sensitivity***.

Such an analytical study would be an excellent alternative to landfill sampling. Landfill sampling can be considered to be similar to a medical biopsy carried out in the dark. With respect to the protection of human health, it is far more important to know what is coming out of the landfill site than what is in the landfill. Even one hundred core samples represent only a minuscule fraction of the landfill's volume. By contrast Leachate and emitted gas samples represent the whole landfill and their analysis will indicate any hazard the landfill may pose to the citizens of Stoney Creek. As part of this study, ***the Panel recommends that MOE also undertake a number of samples at other landfills (some non-hazardous industrial and some municipal solid waste) for comparative purposes.***

In short, the Expert Panel finds the current regulatory framework appropriate for protecting human and ecosystem health, provided that it is extended as outlined in the various recommendations made in this Report. The implementation of our recommendations would necessitate more rigorous testing and monitoring of what goes in and what comes out of the East Landfill. As an extra precaution, the Panel's recommendations also include a health study to assess whether there is a difference in the health status of the community living close to the landfill compared with similar populations living elsewhere.

The Expert Panel has wrestled with the question of whether the existing regulatory framework should be extended to include a protocol for testing what is actually in landfills with a view to monitoring the changes that are taking place in the emplaced wastes. To embark on a program of landfill sampling would be ambitious, costly, and ultimately of little value without an appropriate regulatory framework and data from many landfills. We do not see the need for undertaking such an exercise at the present time at the Taro East Landfill. Such an exercise would require extensive scientific study and a regulatory change with province-wide implications and application. In order to meaningfully develop these changes it would be necessary to generate data from different landfills in order to compare and assess the results from testing individual facilities. ***The Panel does recommend that MOE study the advisability and feasibility of developing such a protocol provided that this review is set in the context of an overall review of landfill regulations, and that it takes account of the various other recommendations set out in this Report.***

In its review, the MOE should consider such aspects as sampling protocols, analysis protocols, methods of interpreting results and ultimately, actions that might be taken as a result of any investigation. ***If this review by MOE does result in the development of landfill sampling protocols; and if the CLC subsequently decides that appropriate***

sampling of the East Landfill (based on any protocols developed by MOE) would improve public understanding and confidence, and hence requests that East Landfill sampling be carried out, then the Panel would support this decision (assuming of course that precautions are taken to ensure that the environment, human health and the integrity of the landfill liner are protected).

8.2 HAS THE LANDFILL BEEN WELL ENGINEERED?

In establishing a frame of reference, it is useful to note that the East Landfill is a relatively small landfill with an average of about 107,000 m^3/ha of waste[40] and a barrier system which exceeds that required by Ontario Reg. 232/98. The barrier system for the Taro East Landfill was in fact designed on a much more restrictive interpretation of the MOE's "Reasonable Use Policy" than that adopted in the more recent landfill standards and[41] assumes that no additional degradation of ground water quality would be acceptable. In other words the landfill has been designed such that there will be no measurable escape of contaminants to ground water even though regulations would allow some limited but measurable escape.

The barrier system[42] at this site consists of a primary leachate collection system, a 1m thick composite primary liner, a 0.5m thick hydraulic control layer, and a 1m thick secondary compacted clay liner over a groundwater collection system.

The design concept is for the site to operate as a hydraulic containment landfill (sometimes called a "hydraulic trap") after landfilling is completed. This concept involves controlling the leachate levels in the landfill to below the water level that is to be maintained in the hydraulic control layer. This would induce a small flow of water into the landfill. Since the driving force for fluid movement is into the landfill, leachate can not escape to contaminate the groundwater as long as this hydraulic containment is maintained. There is still the potential for a small amount of contaminants to migrate outward by a chemical process called diffusion.[43] Diffusion is a very slow and predictable process and calculations can be performed to provide assurance that the impacts will be negligible at the site boundary. When some contaminants (e.g. chloride) do diffuse through the primary liner they can be controlled by flushing the hydraulic control layer to minimize any outward diffusive gradient across the secondary liner. The "hydraulic trap" design is conceptually very similar to that of the Halton Landfill near Milton.

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[40] Certificate of Approval (No. A 181008) indicates a landfill area of 59.1 ha and a maximum capacity of 6,320,000 m^3 (Condition 21). Some municipal sites are much larger.

[41] Taro East Quarry Environmental Assessment, Design and Operations Report, Gartner Lee Ltd., January 1995, p. 23.

[42] Taro East Quarry Environmental Assessment, Design and Operations Report, Gartner Lee Ltd., January 1995, pp. 25-45.

[43] Diffusion involves the movement of atoms or molecules from locations of higher concentration to locations of lower concentration. The diffusive gradient is the difference in concentration between two points divided by the distance between those points.

For the landfill to operate as a "hydraulic trap" the hydraulic control layer must be filled with water (saturated) to a level above the leachate level. This layer can be used to monitor contaminant concentrations and could also be used as a contingency measure to control contaminant migration if there was some unexpected change in conditions. Thus the basic design has a built in level of additional protection that is not often found in landfills in Ontario (in this regard it is again similar to the Halton Landfill).

The hydraulic control layer can not be saturated until all of the barrier system has been constructed. Thus for the operating life of the landfill there are outward gradients from the leachate collection system to the groundwater system. If the primary liner were a simple compacted clay liner there would be the potential for a very small outward flow of leachate. To substantially reduce this flow, the design incorporates a 2mm thick plastic (called a "geomembrane") liner above the primary clay liner.

If well constructed, this combination of a geomembrane and compacted clay liner can provide an excellent barrier for controlling the migration of leachate. The design really only requires this geomembrane to be functional for the operating life of the landfill (about 20 years). In reality the geomembrane likely has a much longer service life (potentially a hundred years or more based on service lives given in Ontario Regulation 232/98). During this period the geomembrane can be expected to act as an excellent diffusion barrier (and in particular an excellent barrier to the diffusion of chloride which, as noted above, is a critical contaminant at this site). Thus although the designers appear to have initially underestimated the potential significance of chloride as a critical contaminant, they have nevertheless developed a design that is ideal for controlling the migration of chloride (and similar potential contaminants).

While the geomembrane is intact there will be negligible flow of groundwater into the landfill due to the "hydraulic trap." Thus in reality the geomembrane is likely to be the primary barrier to contaminant migration for well beyond the operating life of the landfill. When the geomembrane eventually degrades to the point where it can no longer contain contaminants, the hydraulic trap will then become effective.

In summary, the design concept is "state-of-the-art" with several levels of backup that can be relied upon if some component of the system does not work as intended. There are, however, a few ways in which the design can be improved that warrant consideration as discussed in the Appendix D. ***It is recommended that the designers consider the suggestions made in Appendix D in future design and construction activities related to the Taro East landfill.***

8.3 IS THE LANDFILL HARMFUL TO HUMAN HEALTH OR THE ECOSYSTEM?

Modern landfill design is directed to mitigating potential exposures and impacts. Notwithstanding these safeguards, landfills have the potential to cause health effects through a number of "pathways" including from **leachate transportation and disposal**,

groundwater and surface water contamination, and air emissions. Each of these pathways must be considered in relation to the East Landfill.

8.3.1 Landfill Leachate Quality and Treatment Issues

8.3.1.1 Background

Leachate is the contaminated liquid which builds up in a landfill site. Leachate forms when precipitation (rain or snow) or other water comes into contact with the wastes in a landfill, and it contains chemicals which have "leached" out of the landfill including dissolved solids and the products of decomposition of organic matter.

The volume of leachate generated by a landfill depends on the amount of precipitation getting into the landfill. Operating landfills generate more leachate than closed landfills, because closed landfills have been capped and vegetated. This reduces the amount of water getting into the landfill, and thus the amount of leachate being produced.

The composition or quality of leachate in a landfill reflects the types of the wastes contained in the landfill, and the chemical reactions which are taking place. The leachate quality is a direct and ongoing indicator of how the waste is changing. Concerns have been raised by both the CLC and members of the public about the treatment and discharge of leachate from Taro, in particular whether the treatment of West Landfill leachate provided by the Woodward Avenue WWTP is adequate. There is also some public concern about a proposal to direct leachate from the East Landfill to the Woodward Avenue WWTP.

8.3.1.2 Leachate Characteristics

The Taro East Landfill was designed based on an extrapolation of data from the Taro West Landfill.[44] The indicator parameters selected at the time[45] were pH, conductivity, total phenol, ammonia, fluoride, bromide, calcium, potassium, sodium, total organic carbon (TOC), benzene and ethylbenzene. Chloride (a common contaminant examined in landfill design and often the most critical contaminant which controls the landfill design) was "not considered a critical contaminant or indicator parameter in the East Quarry Landfill leachate."[46] At the time of this review, the Expert Panel has been provided with the actual leachate data for the East Landfill up to and including the sampling on 1 March 2000. The following comments are based on both the predicted and the observed leachate characteristics.

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[44] Taro East Quarry Environmental Assessment, Waste and Leachate Characterization Report, Gartner Lee Ltd., January 1995, Table 3, p. 17.

[45] Taro East Quarry Environmental Assessment, Waste and Leachate Characterization Report, Gartner Lee Ltd., January 1995, p. 21.

[46] At the time of the EA, the consultants were persuaded that the major source of chloride in the West Landfill was a waste stream (aluminum processing wastes) that would be excluded from the East Landfill to avoid high chloride concentrations in the leachate.

Table 1 summarizes the leachate characteristics typically assumed in:

- the design of MSW landfills[47]
- the peak annual average concentrations reported for the Keele Valley Landfill (Toronto's municipal solid waste landfill)
- the "predicted" average leachate concentrations for the East Landfill
- the observed maximum and average leachate concentrations
- observed leachate characteristics at the only approved hazardous waste site in Ontario
- the Ontario Drinking Water Objectives (ODWO) for a number of important parameters.

The leachate analyses are understood to be performed usually on leachate collected at the sump (i.e., after it has passed through the leachate collection system). On one occasion (26 March 1997) leachate was also sampled in the collection system up-gradient from the sump. The data for this "up-gradient" leachate gave concentration of VOC's (Volatile Organic Compounds such as benzene, dichloromethane and toluene) and organic load (in terms of chemical oxygen demand, COD, and biochemical oxygen demand, BOD) and chloride that correspond to the maximum values given in Table 1. Thus, as might be expected, it can be inferred that at some locations in the landfill the leachate strength is greater than at others; and that the leachate at the sump represents a blend or "average" of the leachate being generated at different locations in the landfill. A similar comment could be made about any landfill facility. Leachate composition, concentration and volume vary between and within sites. Even the season and climate can affect leachate composition and generation rates (Lisk, 1991). It should be noted that the leachate from the East Landfill **is not diluted** with ground water or surface water as is the case of that for the West Landfill.

Inspection of Table 1 indicates that:

- The concentrations of the volatile organic compounds (VOC's) such as benzene, 1,4 dichlorobenzene, dichloromethane, toluene and vinyl chloride are low relative to the values commonly adopted in MSW landfill design or reported in municipal solid waste leachate at the Keele Valley landfill.
- The concentrations of the heavy metals cadmium and lead are low relative to the values commonly adopted in MSW landfill design and reported in Keele Valley landfill leachate.
- The leachate has elevated concentrations of inorganic parameters including chloride, sodium, calcium, and potassium.
- The observed average concentrations of potassium, ammonia, phenols and calcium are less than the predicted average values.

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[47] Ontario Regulation 232/98, Table 1. Note these are values a designer may use to design a landfill if they do not have better data for their own leachate. They **do not** represent maximum allowable values.

Table 1

Leachate Characteristics: Expectations, Observations and Comparison to Hazardous Waste Leachate and Drinking Water Objectives

Parameter (units)	Landfill Standards[48]	Keele Valley Landfill[49] (MSW) Average[50]	Taro East Predicted [51] Average	Taro East Observed Max [52]	Taro East Observed Average	Hazardous Waste Leachate Observed Pre-1986 Average[53]	Hazardous Waste Leachate Observed Post-1986 Average[54]	ODWO[55]
Benzene (µg/L)	20	<20		52	7.5	3110	200	5
Cadmium (mg/L)	0.05	0.024	0.287	0.01	0.004			0.005
Chloride (mg/L)	1,500-2,500	2,979	150	6,200	2,609	25,981	78,000	250
Lead (mg/L)	0.6	0.1	0.003	0.05	0.018	.321	<0.01	0.01
1,4 Dichlorobenzene (µg/L)	10	10		ND[56]	ND	5	<2	1
Dichloromethane (µg/L)	3,300	3,272		75.7	<15.8	2457	753	50
Toluene (µg/L)	1,000	950		99.3	10.4	3326	551	24
Vinyl Chloride (µg/L)	55	55		ND	ND	316	<10	2
Sodium (mg/L)			629	4,040	1,905	21,977	63,870	200
Potassium (mg/L)			1,923	891	344	317	3,850	
PH (-)		5.8-7.4	10.65	6.46-8.08	7.5	8.47	10.55	6.5-8.5
Ammonia (mg/L)			23	25.6	10.8			
Phenols (mg/L)			11.6	16	1.45	45,378	116,660	
Calcium (mg/L)		1,539	931	777	501	491	425	

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[48] Ontario Regulation 232/98, Table 1. Note these are values a designer may use to design a landfill if they do not have better data for their own leachate. They **do not** represent maximum allowable values.

[49] The Keele Valley is a modern municipal landfill.

[50] Peak annual average values based on either Armstrong, M.D. and Rowe, R.K. (1999) "Effect of landfill operations on the quality of municipal solid waste leachate." Proceedings of 7th International Landfill Symposium, Sardinia, II, pp. 81-88. or Rowe, R.K. (1995). "Leachate characterization for MSW landfills," Proceedings 5th International Landfill Symposium, Sardinia, Italy, Vol. 2, pp. 327-344.

[51] Taro East Quarry Environmental Assessment, Waste and Leachate Characterization Report, Gartner Lee Ltd., January 1995, p. 21.

[52] Based on monthly data except for pH, phenols, chloride, benzene & toluene which are based on a larger data set which includes some weekly data to April 2000.

[53] Pre-1986 Leachate for Laidlaw Environmental Service Lambton Facility, Volume 1, April 1996 EA Submission.

[54] Post-1986 Leachate for Laidlaw Environmental Service Lambton Facility, Volume 1, April 1996 EA Submission.

[55] MOE: Ontario Drinking Water Standards.

[56] ND+ Non-detect at the stated method detection limit.

- The observed concentrations of chloride and sodium are considerably above predicted values (as acknowledged in recent monitoring reports).
- The concentrations of hydrocarbons (benzene, toluene, phenols), chlorinated solvents (dichloromethane, vinyl chloride), and salts (sodium chloride) are all well below (typically by one to two orders of magnitude) those observed in hazardous waste leachate.

Based on the available leachate data, it appears that there is little ground for concern regarding the potential for contamination of ground water due to either volatile organic compounds or heavy metals even if the leachate were to escape the site. Indeed relatively little attenuation would be required to meet the MOE's "Reasonable Use Policy" (See glossary in Appendix E) even if there were no barrier. There is, however, a significant barrier system (as discussed elsewhere in this report) that affords additional protection.

The major discrepancy between the design predictions and the observed leachate characteristics is with respect to what is known as common salt (sodium chloride). The concentrations of both sodium and chloride greatly exceed the expected values and in the case of chloride exceed the anticipated values by more than an order of magnitude (i.e., by more than a factor of ten). It appears that the exclusion of chloride from the list of critical or indicator parameters[57] was not justified, and it is the most critical contaminant with respect to meeting the MOE's "Reasonable Use Policy" requirements at this site. Chloride is monitored and its significance has been recognized in recent Annual Monitoring Reports. As well, the landfill has been adequately designed for chloride even if its significance was not fully appreciated at the time that it was designed. Based on the available data, since the site is adequately designed to protect groundwater with respect to chloride, it will also provide adequate protection with respect to the other contaminants identified in the leachate (including heavy metals and VOC's).

Cyanide was not considered as a critical contaminant but has attracted interest because of the CyanoKEM Waste. An examination of the actual leachate data indicates a maximum total cyanide concentration of 0.123 mg/L (on 27 June 1997) with an average of 0.015 mg/L. The maximum value is less than the Maximum Acceptable Concentration (MAC) of 0.2mg/L defined by the MOE for drinking water.[58] The average concentration is only 7.5% of the MAC. In 1999-2000 the reported concentration has been 0.009 mg/L or less with an average of 0.006 mg/L (3% of the MAC). There is also a very significant barrier system separating the leachate from the groundwater. It will certainly provide adequate protection for cyanide even if the concentration of cyanide in the leachate were to increase by one to two orders of magnitude (i.e., by a factor of 10 to 100 times) above the levels observed over the past year.

Trichloroethylene (TCE) has also been mentioned as a contaminant of concern related to the CyanoKem Waste. An inspection of the leachate data shows a maximum concentration (observed on March 26, 1997) of 9 μg/L and more often than not it is not detected at all. These values are all well below the MAC (Maximum Acceptable

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[57] Taro East Quarry Environmental Assessment, Waste and Leachate Characterization Report, Gartner Lee Ltd., January 1995, Table 3, p. 17.

[58] MOE: Ontario Drinking Water Standards (Regulation 459/00).

Concentration) for drinking water of 50 µg/L and hence, with respect to TCE, the leachate requires no attenuation to meet the provincial Reasonable Use Guidelines.

Although an extensive scan for organic and inorganic chemicals in the leachate is routinely performed as part of the ongoing monitoring activities, given public concern, ***it is recommended that a full scan that includes an examination for organic compounds, especially synthetic compounds that have been of concern in hazardous, industrial and municipal waste leachate (including PCBs, furans and dioxins such as 2,3,7,8 tetrachloro-dibenzo-p-dioxin (2,3,7,8-TCDD)), be conducted once a year. It is also recommended that arsenic be added to the list of parameters monitored and that all parameters specified in the CofA be monitored (e.g. fluoride has been missed).*** This recommendation is an extra precaution – there is no evidence that harmful compounds are being produced and overlooked by the current testing procedures.

8.3.2 Leachate Quality and Quantity – Taro East and West Landfills

The Company is required to analyze the leachate from the East and West Landfills for a broad range of parameters on a regular basis. As indicated above, the Panel has reviewed the available data on leachate quality for both the East and West Landfills. To put the results in context with respect to local landfills, the data are also compared to leachate quality data for the City's Glanbrook Landfill. Table 2 provides a comparison of selected parameters in leachate from the West Landfill, the East Landfill and the Glanbrook Landfill, together with the sewer use By-Law and overstrength limits for Hamilton and other jurisdictions.

As can be seen from Table 2, the leachate from the three landfills is generally comparable in strength. Some parameters are higher at the East Landfill, some are higher at the West Landfill, and some are higher at Glanbrook. These differences will be due to a combination of factors, including the different ages of the landfills and the different waste streams received by the landfills.

Leachate quality from the Taro Landfills is about what one would expect from such facilities. The leachate quality data indicate that the non-hazardous and stabilized wastes in the landfills are contained, with no evidence of significant metals or specific or unusual levels of organics in the leachate.

Chloride levels are recognized as an exception as they are high in the Taro and Glanbrook leachates. However, this is not an uncommon occurrence even in municipal landfill leachates as reported in the literature.[59] The leachate quality data for both the East and West Landfills do not provide any indications of deposition of hazardous waste in either landfill.

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[59] E.g. see Rowe, R.K. (1995). "Leachate characterization for MSW landfills." Proceedings 5th International Landfill Symposium, Sardinia, Italy, Vol. 2, pp. 327-344.

8.3.3 Leachate Treatment Issues

Landfill leachate is frequently discharged into the sewer system for treatment at wastewater treatment plants (WWTP's). For example,

- leachate from the Erb St. landfill goes to the Waterloo WWTP;
- leachate from Maidstone landfill has gone to Windsor's Little River WWTP[60];
- leachate from the Park Road landfill goes to Niagara's Baker Road WWTP.

Biological processes with long biological sludge ages (solids retention times) are often used at WWTP's to degrade difficult pollutants in complex industrial wastewaters. For example, the Elmira WWTP was designed to handle high TKN (organic plus ammonia nitrogen) and phenolics concentrations from the Uniroyal Chemical facility. Similarly, biological systems are used in the steel industry for contaminant removal and have been shown capable of removing trace organics. The Woodward Avenue plant uses conventional primary and secondary biological treatment systems with chlorine-based disinfection for all wastewaters received from the Hamilton catchment area.

In Ontario, discharges to municipal sewer systems are regulated under sewer use By-Laws, with each municipality establishing its own specific By-Law limits. The MOE provides guidance through the "model sewer use By-Law." A new model By-Law was proposed in 1998, but it has not yet officially replaced the 1988 model By-Law. The Hamilton-Wentworth Region has its own Sewer Use By -Law. By-Law concentration levels for certain contaminants are shown in Table 2.

8.3.3.1 Taro West Landfill Leachate Treatment

By agreement, leachate from the Taro West Landfill is discharged to the City sewer system at an average flow of about 1,081,000 Litres per day and is treated at the Woodward Avenue WWTP. This would be equivalent to about 30 round-trip tanker trucks per day if the leachate could not be pumped. Of note, this is roughly ten times the number of trucks, which are used today to haul Taro East leachate away. This represents about 0.3% of the total daily flow into the WWTP plant.

Three agreements reached in 1993 with the Region set out the terms of this arrangement:

- the "Letter of Agreement for Compliance Program for the West Quarry Landfill Site";
- the "Sanitary Sewer Surcharge Agreement";
- the "Overstrength Discharge Agreement."

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[60] It currently goes to the West Windsor Plant where it receives primary physical-chemical treatment and disinfection.

Table 2
Sewer Use By-Law Limits and Other Objectives in mg/L

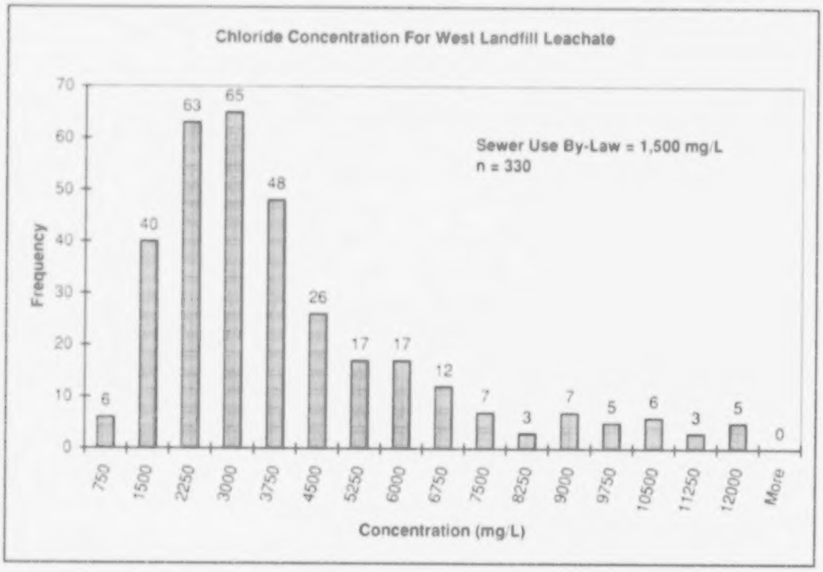
Parameter	Hamilton-Wentworth		Toronto (April '00)	Brantford (Jan '91)	MOE (1998)	Glenbrook Landfill Leachate		ODWO (MAC)	PWQO	Taro East			Taro East MISA			Taro West			Taro West MISA		
(mg/L)	SUBL	Overstrength Agreement	Draft SUBL	SUBL	Draft SUBL	Location LM1	Location LMC			Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max
BOD_5	300	800	300	300	300	90-105	46-64	-	-	196	2.9	1,700	137	2.9	1,020	44	0.7	654	52	5	179
Cadmium	1.0	-	0.7	1.0	0.7	<0.0006	0.0020-0.0024	0.005	0.0002	-	-	-	0.004	ND	0.01	-	-	-	0.0002	ND	0.0002
Chloride	1,500	-	-	1,500	-	1860-2555	7250-7625	250 *	-	2,609	280	5,010	2,104	280	5,010	3,618	489	12,000	3,690	1,340	8,880
Cyanide (total)	2.0	-	2.0	2.0	2.0	0.022-0.0029	0.007-0.017	0.2	0.005	-	-	-	0.015	0.002	0.123	-	-	-	0.007	0.002	0.015
Phenols (total)	1.0	10	1.0	1.0	1.0	0.012-0.018	0.003-0.011	-	0.001	1.5	0.002	18	0.154	0.002	0.46	1.07	0.001	7.37	1.7	0.017	6.8
Sulfate	1,500	-	-	1,500	-	<50	<200	500 *	-	3,992	980	6,200	3,631	2,000	6,190	1,212	9.1	2,200	1,221	775	1,740
TKN	100	830	100	100	100	333-825	650-653	-	-	31	1.1	84	19.2	1.1	60	80	11	262	96	34	252
pH	5.5-9.5	-	6.0-11.5	6.0-9.5	6.0-10.0	7.47-7.50	6.99-7.22	6.5-8.5	6.5-8.5	7.5	6.5	8.0	7.6	7.3	8.0	9.0	7.1	11.8	9.6	7.7	12.2
m- & p-cresol	-	-	-	-	-	-	-	-	0.001	-	-	-	0.060	ND	0.435	-	-	-	0.5	ND	1.46
o-cresol	-	-	-	-	-	-	-	-	0.001	-	-	-	0.011	ND	0.035	-	-	-	0.025	ND	0.077
2,4 Dimethylphenol	-	-	-	-	-	-	-	-	0.01	-	-	-	0.0073	ND	0.032	-	-	-	0.066	0.001	0.193
Ethylbenzene	-	-	0.16	-	0.16	-	-	0.0024 *	0.008	0.002	0.0001	0.013	0.0004	ND	0.0006	0	0	0	0.0003	ND	0.0004
Phenol	-	-	-	-	-	-	-	-	0.005	-	-	-	0.324	ND	7.98	-	-	-	0.771	ND	2.11
Toluene	-	-	0.016	-	0.27	-	-	0.024 *	0.0008	0.01	0.0002	0.099	0.0025	ND	0.0326	0.8	0.8	0.8	0.0012	ND	0.0023
Trichloroethylene, TCE	-	-	0.4	-	0.07	-	-	0.05	0.02	-	-	-	0.0007	ND	0.009	-	-	-	0.0002	ND	0.0002
m-xylene	-	-	-	-	-	-	-	-	0.002	-	-	-				-	-	-	-	-	-
p-xylene	-	-	-	-	-	-	-	-	0.03	-	-	-				-	-	-	-	-	-
m-&p-xylene	-	-	-	-	-	-	-	-	-	0.0066	0.0002	0.046	0.0014	ND	0.0032	1	1	1	0.001	ND	0.002
o-xylene	-	-	-	-	-	-	-	-	-	0.0053	0.0001	0.027	0.0007	ND	0.0014	1.4	1.4	1.4	0.001	ND	0.0014
Xylenes (total)	-	-	1.4	-	-	-	-	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-

* not health related objective; based on aesthetics

Compared to the Region's Sewer Use By-Law, the leachate is often overstrength (i.e., exceeds the By-Law) for a number of parameters including biochemical oxygen demand (BOD), phenols, and TKN. As per the overstrength agreements with the Region, the Company pays surcharges to the Region for the overstrength parameters.

Chloride concentration limits for Taro West are included in the compliance agreement, which limited chloride concentration to a "not to exceed value" of 42,678 mg/L which is well above the standard By-Law limit of 1,500 mg/L, pending construction of a pre-treatment plant for chloride removal. Average Taro West Landfill chloride concentration is about 4,000 mg/L and the distribution of concentration is shown in Figure 1.

Figure 1
Chloride Concentration For West Landfill Leachate



8.3.3.1.1 The Woodward Avenue WWTP

Today Taro West leachate and groundwater dilution is discharged to the sewer system and thence to the Woodward Avenue WWTP. The Taro West leachate consists of all of the water pumped from the wells used within the Taro West boundary. This consists of the landfill leachate captured within the groundwater pumped to protect the zone beneath Taro West.

The Panel has heard the CLC and public express concerns about operational problems at the Woodward Avenue WWTP. Regional officials acknowledged that the plant was on by-pass and thus discharging untreated sewage to Hamilton Bay for 549 hours (or about 6% of the time) in 1999. This represents a total of about 23 days in 1999, but figures are not available on the total flow bypassed and consequent mass loading of contaminants to the harbour.

The Panel is concerned about the operational problems which these figures reflect, and ***strongly recommends continuation (and if possible acceleration) of any necessary upgrades to the sewer system and the Woodward Avenue WWTP by the City to avoid these bypasses.***

The Panel is also concerned about landfill leachate going untreated into Hamilton Bay during by-pass events, and ***recommends that the WWTP and Philip develop a notification system under which the Company will hold back the leachate at the landfill during by-pass events.***[61]

The Panel notes that the Woodward plant has recently undergone capital upgrades which will improve performance, including for example new primary clarifiers, and new activated sludge waste thickening. Secondary clarifier improvements are underway, and future aeration improvements are pending. The Panel strongly encourages that the pending plant upgrades are undertaken as soon as possible.

The leachate characteristics do not appear to be a cause for concern with respect to receiving water quality in Hamilton Bay following treatment at the Woodward Avenue WWTP. This is confirmed by a study carried out for the Region by Conestoga Rovers and Associates (Taro Leachate Quality Assessment, March 1999) on the ability of the WWTP to handle West and East leachate. It is also of importance that activated sludge treatment is a common treatment method for landfill leachates as noted by the US EPA.[62] Based on respirometry studies, Conestoga Rovers and Associates (CRA) did not observe any inhibitory effect of Taro landfill leachate on the Woodward WWTP activated sludge biomass. CRA concluded that the anticipated leachate loads from the West and/or East landfills would not be expected to be inhibitory to the biomass.

The Panel notes that the Woodward plant is already taking and treating leachate from the Region's other landfills including Glanbrook, Ancaster, Brampton St. and Upper Ottawa.

Although the Taro East and West leachates appear to be of relatively low organic strength, ***the Panel recommends that a study be undertaken to examine whether the addition of Taro East landfill leachate to the Woodward WWTP would or would not***

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[61] The Woodward WWTP bypass events result from the old sewer system through parts of Hamilton, which results in high flows to the WWTP during wet weather periods that cannot be handled by the plant (this occurs in many communities - not just Hamilton).

[62] The US EPA concluded that national pre-treatment standards are not necessary for landfills. EPA found that Publicly Owned Treatment Works (POTWs) adequately treated pollutants in landfill wastewater, and only a very small quantity of pollutant loads discharged by landfills to POTWs are further discharged to rivers, streams or estuaries. Furthermore, EPA concluded that wastewater discharges from landfills do not cause operational problems (such as biological inhibition or sludge contamination) for POTWs. (Final Effluent Limitations Guidelines and Pre-treatment Standards for the Landfills Point Source Category Rule1). EPA-821-F-99-016.

have a negative impact with regard to treatment of conventional or specific organic and inorganic compounds. Although the CRA study focussed on respirometry and biomass activity, that study did not appear to review the actual removal of specific contaminants. However, the Panel does not expect any particular problems with contaminant removal with the exception of chloride and sulphate. These soluble constituents are not removed by the conventional treatment systems operated at the Woodward Avenue WWTP.

8.3.3.2 Taro East Landfill Leachate Treatment

Certificate of Approval (CofA) No. A 181008 for the Taro East Landfill stipulates that all leachate collected shall be discharged to the Regional sanitary sewer or an alternative acceptable to the MOE Director (clause 39.2). The CofA mandates that the Company should maintain an agreement with the Region if it discharges leachate to the municipal system. No such compliance agreement has been reached with Hamilton for the Taro East leachate despite the fact that Taro East leachate chloride concentration averages below 3,000 mg/L (Figure 2) which is less than Taro West.

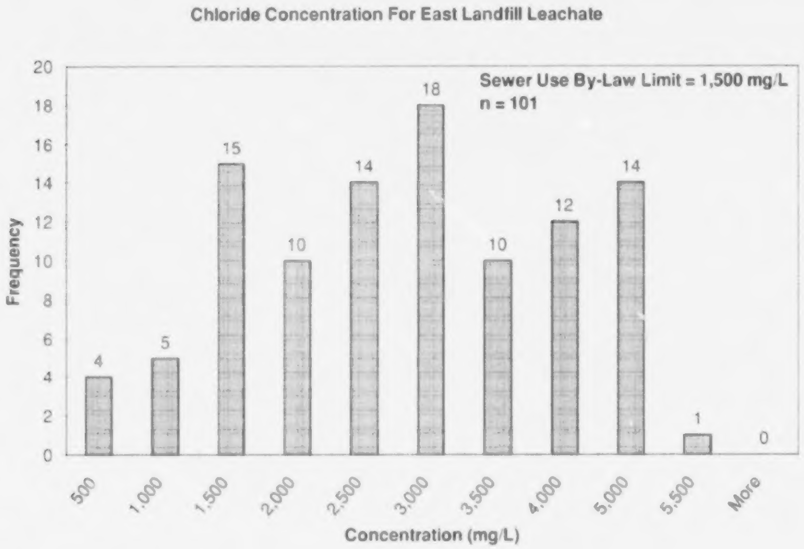
Currently the Taro East leachate is trucked to Brantford and disposed ultimately to the Brantford municipal sewage treatment plant (STP), since no agreement has been formulated with Hamilton to accept Taro East leachate. The quantity today is about 109,000 litres per day on average, and this is expected to increase considerably as the landfill expands. Treated effluent from the Brantford WWTP is discharged to the Grand River flowing to Lake Erie and then to Lake Ontario.

In 1998, Taro hauled 988 truck loads of East leachate to Philip's Brantford facility, amounting to a total of about 31 million litres. The Ontario Clean Water Agency (OCWA), the operator, of the Brantford Municipal WWTP indicates that the plant today has no difficulty, from a conventional treatment standpoint, of handling the discharge from the Philip Brantford facility. The WWTP reportedly achieves effluent characteristics that are well within its CofA (personal communication with plant superintendent). Chloride has not been observed to be a significant issue from the standpoint of wastewater treatment at the concentrations experienced. However, the leachate volume and number of trucks can be expected to increase by about 4 times towards landfill closure.

It is evident that the leachate from Taro East does not meet the Hamilton By-Law for chloride (or sulphate) concentration. Nor has a "compliance agreement" been established for Taro East as has been done for Taro West. Figure 2 shows the distribution of chloride concentration results reported by Taro for the East Landfill leachate.

Other parameters of concern such as cadmium and cyanide are well below the Sewer Use By-Law limits. And other less critical parameters (such as biochemical oxygen demand and total Kjeldahl nitrogen) are generally within either the By-Law limits or overstrength agreement limits that have been specified by Hamilton for Taro West.

Figure 2
Chloride Concentration for East Landfill Leachate



Specific organics (ethylbenzene, toluene, trichloroethylene and xylenes) are much lower than the draft sewer use By-Law limits for the City of Toronto (April, 2000) which is the first municipality in Ontario to provide these type of limits in their By-Law. Hamilton has not yet adopted similar limits for organics.

8.3.3.3 Potential for Treatment of Taro East Leachate at the Woodward WWTP

As part of the EA for Taro East, the Company provided rationale for either:

i. direct sanitary sewer discharge
ii. on-site pretreatment and sanitary discharge, or
iii. full on-site treatment

Alternative ii) and iii) above would be needed if the Sewer Use By-Law could not be met - which was deemed unlikely.[63]

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[63] Table D of the Executive Summary: Taro Aggregates Ltd. Proposed East Quarry Landfill Environmental Assessment.

As indicated earlier, the resultant CofA for Taro East specifies that "all collected leachate and/or contaminated water shall be discharged to the Regional sanitary sewer or an alternative acceptable to the Director." This would be done under an agreement with the Region specifying the quantity and quality of the leachate which could be discharged. An agreement however has not been promulgated between Taro and the Region for the East Landfill.[64]

The reason why the East landfill leachate is trucked to Brantford and handled through a Philip subsidiary prior to discharge to the Brantford municipal WWTP, appears to be, in part, because Taro East leachate does not meet the Sewer Use By-Law for chloride or sulphate. The removal of these salts is difficult and requires intensive systems such as the reverse osmosis "system" that was studied for the West leachate. The system would consist of several complex pretreatment steps before the actual reverse osmosis process. There may also be other environmental and socio-economic impacts on the local area if a pretreatment system is installed. For a variety of reasons, including its cost, the Company has not been compelled to install a pretreatment system at the site.

The Company has indicated that it would prefer to discharge the East Landfill leachate to the sewer system for treatment at the Woodward WWTP, thereby saving the considerable and increasing costs of trucking leachate to Brantford. These costs will otherwise be rising steadily as the footprint of the landfill expands over the next few years resulting in increased leachate production.

The annual hauling costs today to truck the East Landfill leachate (based on the current leachate generation rate of about 31 million Litres per year) were indicated by the Company to be about $450,000. Assuming the Woodward WWTP can handle the East leachate, it would make good sense to eliminate haulage of the leachate from an environmental perspective by eliminating about 1000 heavy truck round trips from Stoney Creek to Brantford yearly. Leachate trucking traffic impacts would also be reduced. The amount of leachate to be trucked away will increase by approximately a factor of four from today's volume by the time the East Landfill is closed. Without an approved sewer connection for Taro East, this will result in greatly increased trucking traffic and cost.

Negotiations to arrive at an agreement between the Region and Taro on discharging East Landfill leachate to the sewer system have stalled over a number of issues:

1) The failure of the Company and the Region to implement a "compliance agreement" for the East Landfill leachate, at least in part predicated on the exceedence of the chloride above By-Law limits.

2) Concerns expressed that addition of the East Leachate could impair the operation of the Woodward Avenue WWTP.

3) Concerns expressed that hazardous wastes may have been deposited illegally, presumably based in part on the publication of the MOE review by Officer Robertson.

These issues are discussed in turn below.

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[64] An agreement is in place for the West Landfill.

8.3.3.3.1 The Chloride Issue

Chloride in the leachate is an issue because the Hamilton-Wentworth Sewer Use By-Law limits chloride to a maximum of 1500 mg/L, a level which is usually exceeded in East Landfill leachate (see Figure 2) as well as the other leachates mentioned earlier, including the West landfill.

Chloride is not included in the overstrength agreement as a surchargeable parameter. At the Woodward WWTP there is no indication from Regional staff that it causes treatment problems at the levels experienced today (Jeff McIntyre, personal communication). However, chloride is a "conservative" parameter at conventional municipal WWTPs (i.e., chloride is not removed and simply flows through the plant and into the receiving water body).

At the time of the East Landfill EA, the Company had reached a "compliance agreement" with the Region to receive the West landfill leachate having chloride above the Sewer Use By-Law limit. Also at the time of the EA, and during Gartner Lee's EA Waste and Leachate Characterization Report, there was an expectation that chloride would not be an issue for Taro East. After startup of the East Landfill chloride was unexpectedly discovered to be above the Sewer Use By-Law level.

One pre-treatment process for chloride (and sulphate) is reverse osmosis.[65] This is a high-pressure membrane separation approach for removal of dissolved constituents from water. This system would separate most of the chloride and other constituents; however, the water remaining, despite having a higher purity than the raw water, still would require disposal. The concentrated chloride solution would need separate treatment and disposal. Significant conditioning of the raw leachate would be required prior to reverse osmosis as well as post treatment of the waste concentrate from the reverse osmosis (RO) process. The estimated cost of a reverse osmosis system for both East and West leachate was about \$7 to \$8M. In the 1995 report, the conclusion was made that significantly more evaluation of RO would be required before it could be adopted as a technical solution for chloride removal from the leachate.[66]

Regional staff reviewed the proposal for reverse osmosis pre-treatment of West leachate and recommended that alternatives to RO pre-treatment should be considered (Report to ESC 23/2/96). Specifically a trade-off of pre-treatment for chloride removal was recommended due to the much larger quantity of chloride which is discharged to the environment from road salt de-icing in winter. However, this requires Taro to obtain an agreement with the Region to permit the introduction of the leachate with chloride concentration that is above the current By-Law value. More importantly, it appears, from the ESC reports, that the Region is prepared to review the By-Law limit for chloride to be consistent with the direction that the City of Toronto proposes, that is, to remove chloride as a By-Law criterion. To date, however, the Hamilton chloride limit remains.

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[65] Burlington Environmental Inc. – Taro Landfill Leachate Treatment System Evaluation, March 8, 1995.

[66] It is noted that Zenon Environmental Systems Inc. provided a budgetary proposal for a leachate treatment system to Mr. Charles Eleveld on September 28, 1999 indicating a capital cost allowance for an RO system of \$1.4M. This however was only for a flow of 100,000 L/day, which is the current flow from the East landfill only. This flow is expected to quadruple at closure. Further, it does not consider the large flow from Taro West that would also need similar treatment.

The East Landfill leachate is currently treated in the Brantford WWTP, and discharged from the WWTP to the Grand River. The chloride is not removed, and ultimately flows to the Grand River, to Lake Erie, and then to Lake Ontario prior to the outflow to the St. Lawrence. This is where chloride in leachate sent to the Woodward WWTP will also flow to. Thus, the same mass loading of chloride eventually reaches Lake Ontario from the East Landfill, regardless of whether it is the Brantford or Hamilton WWTP where the leachate is processed. As well Brantford is a much smaller plant than Woodward and the Grand River is a sensitive receiver.

The current Region's sewer use By-Law allows no exceptions for chloride or sulphate (both parameters are present in East leachate at levels often exceeding the By-Law) without a "compliance agreement" in place. However, chloride and sulphate have been dropped from the MOE's proposed new model sewer use By-Law, and Toronto has dropped chloride from its sewer use By-Law. The Panel understands that the Region's Sewer Use By-Law is currently under review (communication with Regional staff) and that there is potential that chloride and sulphate may be brought into line with the new MOE model and with Toronto's new By-Law which is under review.

However, until the By-Law is amended the Panel can only recommend that East Landfill leachate be directed to the Woodward WWTP without pre-treatment for chloride under the same conditions as the West leachate, i.e., with a compliance agreement to be negotiated between the parties dependent on the outcome of the Region's pursuit of an amendment to the By-Law for chloride and sulphate. Noting the qualification elow, there are no other significant reasons to exclude the East leachate from the local treatment system.

Although the concentration of chloride from Taro East is above the By-Law, the contribution at Woodward WWTP would only amount to about 12 parts per million of chloride compared to the actual amount entering the plant from other sources of about 400 parts per million.

The Panel has learned that the Region currently has at least two (unnamed) existing Compliance Agreements, which allow overstrength discharges of chloride (ref. Appendix 2 of the February 24th Regional Environmental Services Committee Report). The Panel recommends that the current Sewer Use By-Law limits and policies for chloride and sulphate be reviewed by the Region, and that whatever decision is made with respect to the chloride and sulphate limits should be applicable to all sewer users and uniformly applied across the Region. This appears to be the direction that the Region was intending to take for sewer users.

In the event that the By-Law limits for chloride are changed such that East Landfill leachate would be allowed to the Woodward Avenue WWTP, what would the relative effect of the additional chloride loading be on Hamilton Bay? The Panel has tried to evaluate the Regional context of these issues.

A recent Environment Canada report regarding road salts (Draft Report of the Assessment of the Substance Road Salts Specified on the Priority Substances List) has focussed on the quantity of sodium chloride de-icer salt (~2,950,000 tonnes/year) released to the environment and the potential toxic effects due to chloride ions. The report proposed that road salts be considered "toxic" under Section 64 of the CEPA, 1999.

The City/Region uses about 35,000 tonnes of road salt (sodium chloride) annually. Some of this salt enters the sewer system, and an annual amount of 15,000 tonnes was reported discharged from the Woodward WWTP. By comparison, the East Landfill leachate would contribute approximately 125 tonnes per year (<1%). The Panel has considered the arguments advanced by various parties and has come to the conclusion that the cost to remove chloride from East Landfill leachate by reverse osmosis (RO) pre-treatment appears to be high compared to the benefit that would be achieved. With RO, the treated leachate would continue to require discharge, but it would already be highly treated and thus unproblematic. On the other hand, the RO concentrate (about 20% of the volume of leachate treated) would be high strength and would require separate off-site disposal.

In addition, pre-treatment to remove chloride with RO would require a permanent processing plant in the landfill site area for at least many decades and possibly centuries. This would potentially cause other nuisance impacts to the surrounding community. For this reason, planners for the City of Stoney Creek do not favour the chloride pre-treatment plant. The current zoning of the lands would not allow the construction and operation of a treatment plant (Steve Miazga, Stoney Creek Planning Department, personal communication, August 2000). It would appear that there would be greater benefit by continuing the negotiations between the Company and the Region to accept the East Landfill leachate at the Woodward Avenue WWTP.

As a pre-requisite, the current Region Sewer Use By-Law limits and policies for chloride and sulphate would need to be amended, such that East Landfill leachate could be discharged to the sewer system in compliance with the By-Law. If this occurs, then ***the Panel recommends that any discharge of East Landfill leachate should be subject to the following conditions:***

a) ***The impact of the Taro West and East Landfill leachate on the Woodward Avenue WWTP should be evaluated through experimental pilot plant tests together with scans for metals and trace organics removals and accumulation in biosolids. Discharging of East leachate to the Woodward WWTP should only occur if these tests show that is acceptable.***

b) ***In lieu of a chloride pre-treatment plant (and given savings realized by not building a plant and by eliminating the trucking and handling of leachate off-site), the Company should provide acceptable funding (to be negotiated with the Region) for use of the municipal sewer and WWTP. This funding should be used to assist with the upgrading of the Woodward WWTP.***

8.3.3.3.2 The Woodward WWTP

As discussed for the West Landfill leachate, there does not appear to be any reason to exclude the East leachate from the Woodward WWTP. The Panel recommends a flow-through pilot plant test of the leachate with Woodward WWTP biomass including full organic and inorganic analysis of the removal of specific contaminants of concern. This would supplement the respirometry study completed by CRA and support or not the ability of the WWTP to handle Taro East leachate.

As discussed above, we also recommend that leachate be withheld from the plant during periods of operational upsets or bypasses. This would ensure that the leachate received the maximum available treatment that can be provided by the WWTP.

8.3.3.3.3 The Issue of Hazardous Wastes in the Landfill

The issue of whether hazardous waste is present in the landfill is discussed elsewhere in this report. With the exception of a single load of waste that tested leachate toxic but could not be recovered from the East Landfill, there is no confirmed evidence of any hazardous waste having been deposited in the Landfill in contravention of Regulation 347.

Analysis of the leachate to date has provided no indication of the presence in the landfill of hazardous waste, or any indication that the "stabilized waste" that has been deposited there is leaching dangerous amounts of contaminants. Monitoring must continue, but as long as the leachate remains treatable at the Woodward Ave. WWTP, the leachate can be directed into the sewer system in accordance with the arrangements outlined above.

8.3.4 Summary of Leachate Recommendations

1. ***The Company must ensure continued long term commitment for leachate collection, characterization and treatment. This must be guaranteed in some secure way in the future and for as long as needed (i.e., hundreds of years).***
2. ***The Panel strongly recommends continuation (and if possible acceleration) of any necessary upgrades to the Woodward Avenue WWTP by the City to accommodate the leachate and avoid bypassing the plant.***
3. ***The Panel recommends that the WWTP and the Company develop and implement a notification system under which the Company will hold back the leachate at the landfill during by-pass or upset events.***
4. ***The Panel recommends that the practice of recirculating leachate by spraying should be discontinued. If the Company decides to recirculate the leachate, they should use a trickle method rather than spraying to reduce the potential for VOC release.***
5. ***The Panel recommends that the current Sewer Use By-Law limits and policies for chloride and sulphate be reviewed by the Region, and that whatever decision is made with respect to the chloride and sulphate limits it should be applicable to all sewer users and uniformly applied across the Region. As a pre-requisite, the current Region Sewer Use By-Law limits and policies for chloride and sulphate would need to be amended, such that East Landfill leachate could be discharged to the sewer system in compliance with the By-Law.***

6. ***The Panel recommends that any discharge of East Landfill leachate should be subject to the following conditions:***
    a) ***The impact of the Taro West and East Landfill leachate on the Woodward Avenue WWTP should be evaluated through experimental wastewater treatment pilot plant tests together with scans for metals and trace organics removals and accumulation in biosolids. Discharging of East leachate to the Woodward WWTP should only occur if these tests show that is acceptable.***
    b) ***In lieu of a chloride removal pre-treatment plant (and given savings realized by not building the plant and by eliminating the trucking and handling of leachate off-site), the Company should provide funding (to be negotiated with the Region) for using the sewer system.***
7. ***Leachate should be properly managed at the Taro site to prevent the leachate from causing odour problems.***
8. ***A one-time triple split sample analysis should be completed for all CofA parameters by three certified labs to verify the quality of the Taro leachate analyses to assure the CLC that the results are scientifically valid***

8.3.5 Groundwater Impact Assessment

As pointed out above, based on the available leachate data, there is currently very little potential for contamination of ground water due to either volatile organic compounds or heavy metals. On the contrary, the average levels of VOCs and heavy metals observed in the East Taro leachate very nearly meet the levels required at the site boundary by the MOE's "Reasonable Use Policy." Even at the maximum levels observed there is little scientific basis for concern regarding these contaminants.

This conclusion is quite extraordinary. What it means is that even if there were **no** barrier to prevent this leachate from escaping into the groundwater, very little (if any) damage would occur due to VOCs or heavy metals if it did seep into the ground. Of course this is not what is happening. There is a state-of-the-art barrier system, and all of the leachate is currently being collected and trucked off-site for treatment and disposal.

8.3.5.1 Background Information

The Taro East and West Landfills are situated less than 1 km from the Niagara Escarpment, which is downgradient (to the north) of both. The local groundwater system is characterized by marginal quality groundwater. Groundwater at depth is very salty and not drinkable, with a thin shallow layer of fresher groundwater (near the water table) which is replenished by rainfall.

In some places this fresher layer provides enough drinkable water to support a domestic well, but in most places it does not. There is only one family in the area still known to be using their well for drinking water. This well is downgradient of both the East and the West Landfills.

In assessing local groundwater or surface water impacts, it is not reasonable to try to isolate the East Landfill and assess its impacts only. The Taro operations (quarrying and landfilling in both the East and West Quarry) together have affected local water supplies, and the cumulative effects of these operations on the environment are what local residents have to deal with and therefore they should be assessed together.

8.3.5.2 Groundwater Degradation Caused by Taro Landfills

There is no sign that any leachate contamination from the East Landfill has reached the groundwater flow system beneath or downgradient of the landfill. The leachate barrier and collection system are functioning as designed, and are containing the East Landfill's leachate.

Leachate from the West Landfill has caused groundwater contamination, and mitigation measures (containment wells) are in place and have been used to try to keep the zone of leachate contamination confined to the immediate area of the landfill. Nonetheless, degraded groundwater has been moving northwards from the area of the Taro East and West landfills since at least the early 1990s. It is characterized by a significant rise in levels of chloride and other inorganic parameters in groundwater downgradient (to the north) of the landfills. Areas closest to the landfills generally saw levels peak in the 1992 to 1994 period, with a significant reduction in the magnitude of the degradation since then.

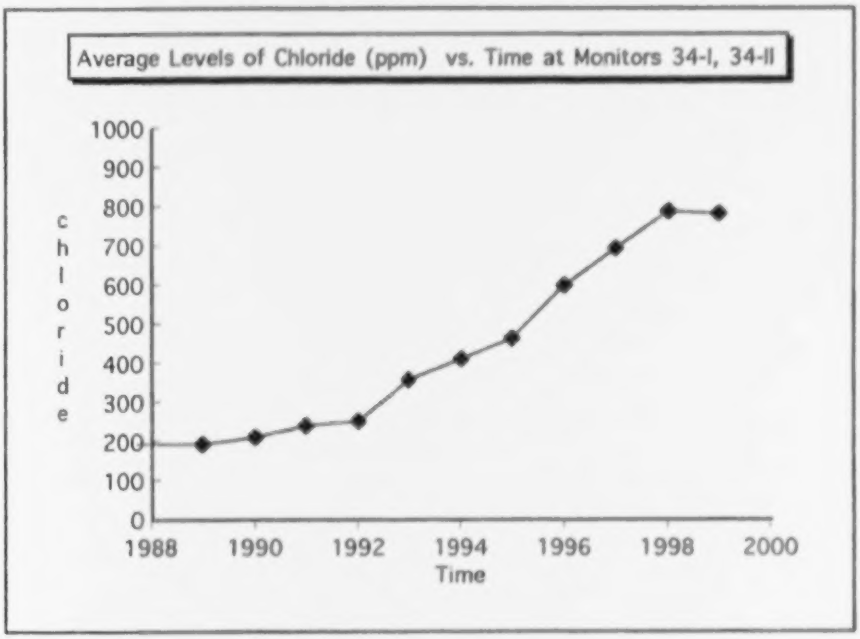
Examples of this degradation of groundwater quality in areas downgradient of the landfills can be seen in the monitoring results for many wells including 6-I, 7-I, 34-I, the Banovac well, the Rental 1 well, and (since 1998) the Utter well (Figure 3a and 3b). The Company's consultants have argued that the groundwater degradation observed in downgradient areas (north of the landfills) was not due to escaped leachate from the West Landfill, but instead was a secondary effect of the pumping of the containment wells. They argue that the pumping of the containment wells led to a salinization of the units being pumped. Regardless of how it occurred however, there is no question that there has been a significant degradation of groundwater quality downgradient (north) of the landfills, and that it was caused by the Taro landfill operations.

In the case of the deeper and already saline groundwater, this degradation of groundwater quality is not a problem because the water quality was so poor to start with that the water was not usable. In the case of the shallow layer of fresher groundwater (which in places is adequate to support a domestic well), increased salinity is of concern. This issue has not been adequately addressed to date. The increased salinity caused by the Taro landfill operations may be the cause of a negative effect on local groundwater supplies.

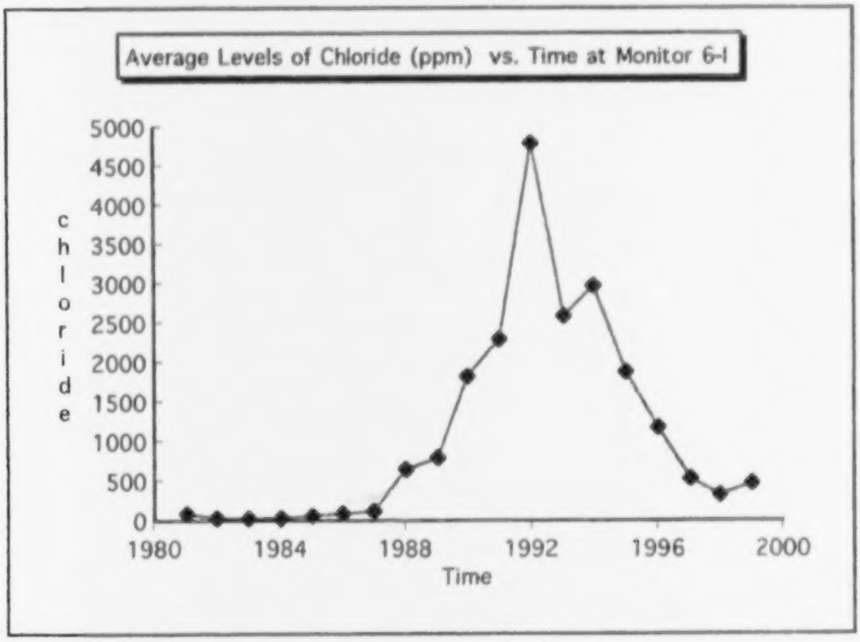
Figures 3a and 3b

Average Levels of Chloride over Time at 2 Groundwater Monitors Downgradient of the Taro Landfills

1989	194
1990	209
1991	244
1992	252
1993	358
1994	412
1995	464
1996	598
1997	696
1998	786
1999	781
(year)	(chloride)



1981	91
1982	28
1983	33
1984	35
1985	52
1986	76
1987	106
1988	639
1989	796
1990	1838
1991	2307
1992	4808
1993	2600
1994	2968
1995	1895
1996	1171
1997	540
1998	316
1999	472
(year)	(chloride)



The extent of impacts (if any) on springs along the Niagara Escarpment is also not well understood, and difficult to determine at this point as monitoring of the springs did not begin until long after the start of the Taro operations. However ongoing regular monitoring of the springs is warranted.

8.3.6 Surface Water Impact Assessment

8.3.6.1 Background Information

The East Landfill, East Quarry and the West Landfill are situated in a changing watershed, characterized by ongoing urbanization of upstream areas of Davis Creek (the receiving surface water for any flows from the landfills). Water quality in Davis Creek is not pristine, and the creek itself has been severely altered (it runs in a concrete channel for a significant portion of its length above Felker's Falls).

The Niagara Escarpment lies downstream of the landfills, and local surface water courses flow over the escarpment. Below the escarpment, Davis Creek feeds into Redhill Creek, which in turn flows into Hamilton Bay. There are apparently no fish in Davis Creek above the escarpment, but a few species of warm water fish inhabit the creek below the escarpment. More than 20 species of fish have been found in Redhill Creek.

Drainage of surface water runoff from the East Quarry is via a ditch flowing north along First Road West (on the west side of the quarry/landfill). There is a surface water monitoring station in the ditch (station T-3). The ditch flows over the escarpment near Ridgeview Drive, and is then carried by storm drain to Davis Creek. Flow from the quarry (which was contaminated by ammonia from blasting) to the ditch was sharply reduced in late 1992, and cut-off in early 1998.

Drainage from the West Landfill is via an intermittent stream channel which reaches the escarpment northeast of Felker's Falls. Flow from the West Landfill to the channel which was contaminated by landfill leachate was cut off around 1993.

8.3.7 Surface Water Impacts

8.3.7.1 East Landfill

The East Landfill has no surface water impacts in the vicinity of the landfill. All surface water is collected together with the leachate, and taken to Brantford for treatment. In the future, once the waste cells receive final cover the storm water runoff from the landfill will be discharged to the roadside ditch at T-3.

8.3.7.2 East Quarry

There have been ongoing surface water quality impacts from the East Quarry since 1989. These impacts were severe until November 1992 when flows were sharply reduced, but they persisted until early 1998 when flow from the quarry to the roadside ditch at T-3 was cut off entirely.

The most significant impacts have been the regular exceedences of the Provincial Water Quality Objectives for unionized ammonia and iron at station T-3 in this ditch from 1989 through 1998. Chloride levels have also been high.

It is very difficult to assess the significance of the surface water discharges from the East Quarry, since flow data for the ditch at T-3 were rarely provided in the Annual Reports. This is a significant deficiency in the surface water monitoring which has been carried out to date.

Taro/Philip's consultants have indicated that flows to the ditch at T-3 were sharply reduced in November 1992, and were "a trickle" since then. This provides some reassurance, but ongoing documentation of flows in the ditch at T-3 would have been much better.

The 1998 Annual Report indicates that the Company implemented measures "to prevent any discharge to the T-3 ditch," thus since 1998 there were no longer ANY surface water discharges (and thus no surface water impacts) from the East Quarry.

8.3.7.3 West Landfill

Surface water from the West Landfill is now collected and treated together with the landfill's leachate. Thus there are currently no surface water impacts in the vicinity of the landfill.

In the past, this landfill has had severe impacts on surface water. Until late 1992, raw leachate from the West Landfill was discharging to a natural watercourse to the north of the landfill which flows over the Niagara Escarpment just below Felker's Falls. Ammonia levels were high enough to be toxic to aquatic life, and peak chloride levels reached the salinity of sea water. This flow was cut off by the Company around late 1992.

By sometime in 2001, once the West Landfill is capped and vegetated, the Company plans to direct surface water back to the natural watercourse which flows over the escarpment just below Felker's Falls. If the area northwest of the West Landfill is developed as a sports park, then storm water management plans for the capped landfill will need to be integrated into the drainage plans for the sports park.

8.3.8 Recommendations Regarding Groundwater and Surface Water Issues

1. ***The overlaps, confusion and inconsistencies between monitoring programs for the quarry and the landfills should be eliminated, by developing a unified monitoring program.***

   Assessment and monitoring of local groundwater and surface water quality should look at the cumulative impacts of all Taro operations.

2. ***The following measures should be implemented to deal with the degradation of groundwater quality downgradient of the Taro landfills:***

    a) ***There should be quarterly monitoring of groundwater quality downgradient of the landfills, at springs T-B and A-1 through A-8 along the Niagara Escarpment. Monitoring should be for the list of "general" parameters and "major ions" specified in Schedule C of the East Landfill's Certificate of Approval.***

    b) ***The Company should offer to cover the costs of annual third party domestic well water quality monitoring for residents living downgradient (north) of the landfills, provided that the results of such sampling are made available to the CLC.***

    c) ***The Company should install at least two additional nests of monitoring wells between the Taro landfills and the Niagara Escarpment, at locations to be determined in consultation with the CLC. These wells should be added to the regular groundwater monitoring program for the landfills.***

    Where the CLC has concerns that groundwater quality on downgradient properties to the north of the Taro landfills may have been degraded as a result of the landfills, this should be reviewed by independent experts (selected by citizen members of the CLC) to determine whether degradation has occurred and whether compensation is warranted. If the experts come to the conclusion that compensation is warranted, the Company should negotiate the level of compensation with the property owner(s) with binding arbitration being used if needed.

3. ***If the area northwest of the West Landfill is developed as a sports park, then storm water management plans for the capped landfill should be integrated into the drainage plans for the sports park. This work should be carried out cooperatively by the Company and the City, with the costs shared between them.***

4. ***All future monitoring of surface water quality should include monitoring of surface water flows in any surface waters receiving storm runoff from the Taro operations. All flow monitoring results should be included in the Annual Monitoring Reports.***

5. ***The plans for discharge of stormwater runoff from the East and West Landfills (including all monitoring and contingency plans) should be reviewed by the CLC before any surface water discharges take place.***

8.3.9 Air Quality Issues

Landfilling operations can impact air quality in various ways. These impacts can be significantly different during the active phases of a landfill and the post-closure phase. During the active phase of a landfill, air quality impacts can arise from:

- Dust
  - nuisance
  - health (fine particulate)
  - containing heavy metals
- Volatile organics
  - from waste
  - from decomposition/waste changes
- Odour
  - nuisance

After closure, many of these sources of air quality impacts are either eliminated or significantly altered. All of the dust sources are eliminated (after cap construction and rehabilitation) and the volatile organic emissions can be reduced due to the cap and landfill cover.

The following sections discuss issues and recommendations related to both the operational phase of the landfill and the post-closure phase.

8.3.9.1 Particulate (Dust)

Currently there are three total suspended particulate (TSP) monitors around the site. Total suspended particulate is a measure of airborne dust that is smaller than about 44 μm (1 um is 10^{-6} m, or one thousandth of a millimeter). These monitors take a 24-hour sample every six days.

The Ministry of the Environment (MOE) has established air quality standards and guidelines intended to ensure that dust levels do not pose visibility problems, either cumulatively (over a full year) or on any given day. The established levels are based on total amounts of dust. Over a full year, the (average) standard is 60 $\mu g/m^3$; the standard for a 24-hour sample is 120 $\mu g/m^3$.

8.3.9.2 Existing Data

The monitors at Taro have been operational since December 1996. Three full years of data are available (1997, 1998, 1999). Results of the monitoring are summarized in Table 3 and Table 4. For comparison, three other Hamilton sites (operated by the Ministry of Environment) are included. A similar urban site (on the mountain), at Vickers Road and E 18th was used (Station 29114). As well, two other sites below the mountain were chosen, one near the steel mills (Gertrude and Depew – Station 29113); and the other in Stoney Creek near Highway 20 and the QEW (Keefer Ct – Station 29143). These stations were chosen to provide a representative range of air quality in the Hamilton and Stoney Creek area.

The data is presented as annual averages (Table 3) and as percentage of days that the monitors recorded exceedances of the 120 μg/m^3 24-hour criteria (Table 4).

Table 3

Annual Average Particulate Concentrations (μg/m^3)

Year	1997	1998	1999
Taro - M1	38.8	34.4	43.7
Taro - M2	43.2	41.5	46.9
Taro - M3	48.2	47.1	51.7
MOE - 29113 (Gertrude/Depew)	82	102	88
MOE - 29114 (Vickers/E 18th)	47	49	39
MOE - 29143 (Keefer - 20/QEW)	77	78	80

Note that none of the Taro results exceeded the MOE standards for long-term exposure to particulate (annual averages).

Table 4

Percent Exceedances of 24-hour Criteria

	1997	1998	1999
Taro - M1	9.5	13.0	17.5
Taro - M2	4.8	8.9	10
Taro - M3	1.8	5.2	7.1
MOE - 29113 (Gertrude/Depew)	19.0	45.0	30.0
MOE - 29114 (Vickers/E 18th)	0	0	2
MOE - 29143 (Keefer - 20/QEW)	8	17	25

This data is presented, graphically in Figures 4 and 5.

Figure 4

Total Suspended Particulate - Annual Average Comparison

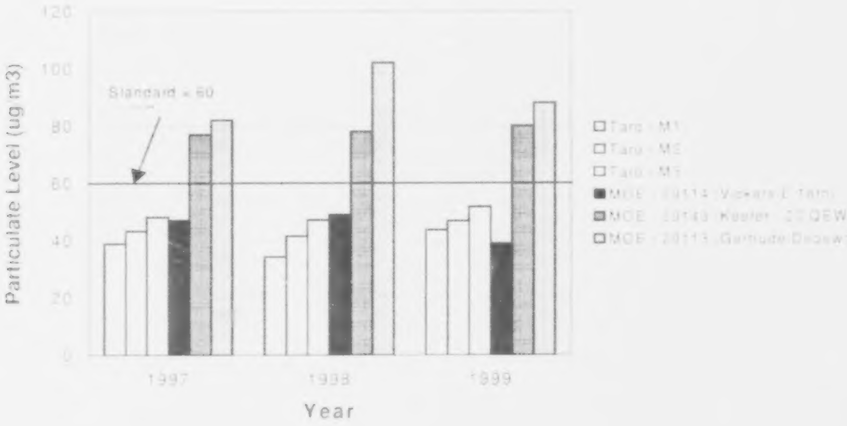


Figure 5

Total Suspended Particulate - % exceedances (samples)

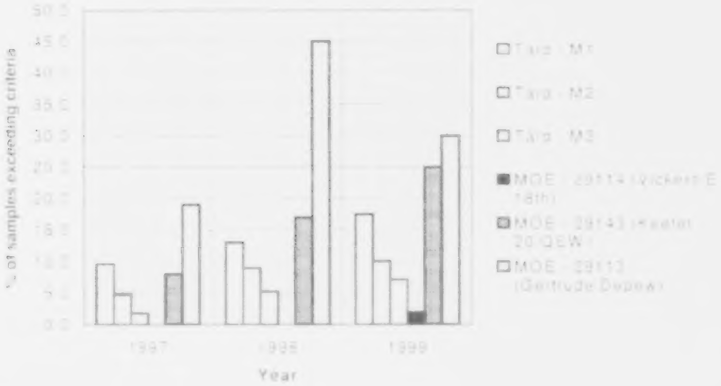


Figure 4

Total Suspended Particulate - Annual Average Comparison

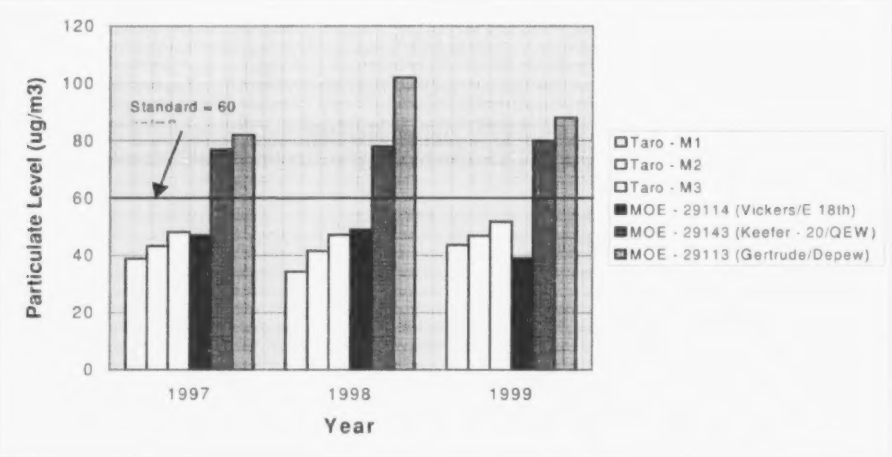
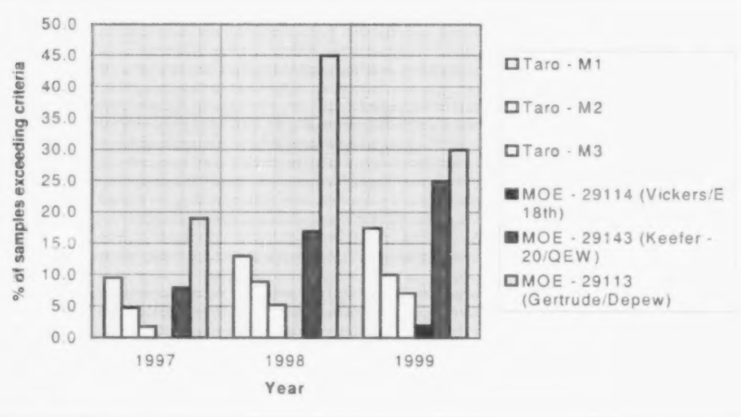


Figure 5

Total Suspended Particulate - % exceedances (samples)



The data indicates that the average particulate levels around the Taro site are similar to levels at Vickers and E 18th. Average levels last year (1999) were a bit higher. This can be attributed to construction work ongoing on the West Landfill. Particulate levels around the site were significantly lower than particulate levels at the two stations below the Mountain.

Table 4 and Figure 5 do indicate that there have been more exceedances of the 24-hour criteria at Taro than at Vickers and 18th. This can be attributed to the quarrying and material handling operations at the site. Similar major construction sources are not present around the Vicker's station. These exceedances are significantly below the percentage of exceedances at the other two sites.

It can be concluded that dust from the Taro operations has likely led to increased exceedences of MOE criteria in the vicinity of the site, but it is important to note that with the completion of the quarrying operations, particulate levels in the area are expected to significantly decrease.

8.3.9.3 Comparison with Predicted Impacts

As part of the Environmental Assessment process, air quality predictions were undertaken by Taro. Predictions were made based on anticipated levels of activity, quarrying operations and traffic in the area. This is summarized in Table 5 and Table 6.

A comparison with predicted and measured data shows a good correlation. Modelled and measured average levels and modelled and measured exceedances at locations near the monitors are consistent, with predicted impacts generally being higher than actual measured impacts.

Table 5
Monitored Particulate Levels as % of Modelled Annual Average

	1997	1998	1999
Taro - M1	83%	67%	98%
Taro - M2	78%	77%	87%
Taro - M3	74%	74%	81%

Table 6
Modelled and Monitored Particulate: Exceedances of 24-hour Criteria

	1997	1998	1999	Modelled
Taro - M1	9.5	13	17.5	13.2
Taro - M2	4.8	8.9	10	6.6
Taro - M3	1.8	5.2	7.1	14

8.3.9.4 Potential Health Impacts - Particulate

"Total particulate" has become less of an environmental concern in recent years. As mentioned above, the initial particulate air quality standards were based on visibility issues and therefore measured "total particulate." In recent years health concerns have become the focus and consequently more attention has been paid to fine particulate (particles less than 2.5 um in size), which are typically produced by combustion. The Canadian Council of Ministers of the Environment (CCME) has developed a target level of 30 $\mu g/m^3$ for fine particulate (PM2.5).

Though it is possible to estimate the fraction of fine particulates in total dust, this is indirect and subject to uncertainty – especially near a quarrying operation. The ratio of fine particulate to total particulates is based on numerous measurements in urban environments. In these environments, very fine combustion particulates (from traffic, oil combustion for heating, etc.) contribute a large portion of the total particulate loading. Near quarries, and landfills, the majority of the particulate comes from crustal material (soil and material handling, crushing). Particulates generated from crustal materials, through crushing and material handling, are extremely coarse when compared to combustion particulates. As a result, a lower percentage of the total dust in the Taro area will be fine particulate. Nevertheless, since no fine particulate monitoring has occurred, typical urban ratios of fine particulate to total particulate are used for estimating fine particulate. These estimates are not precise and, in the case of a landfill or quarry, will likely **over**predict the fine particulate fraction

There have been no measurements of PM2.5 in the vicinity of the Taro site. Estimated levels at the Taro monitors indicate that fine particulate levels are typically below the target levels suggested by CCME. There is one estimated exceedance (42 $\mu g/m^3$) of the target level in 1999. This was attributed to construction activity near the monitor. The possible health implications of high levels of fine particulate will be investigated in the health study program (which is outlined below)

Actually measuring the fine particle size fraction (instead of merely trying to estimate it) would allow easier comparison of the results with fine particulate health standards.

The Regional Health Unit commented on the need for small particle monitoring in its initial review of the Community Health Assessment and reiterated this recommendation in their review of the Bertell/Dixon report.[67]

The Bertell/Dixon report recommends to the CLC, "That it ensure that air monitoring is carried out in a manner which independently measures the fence-line concentrations of the airborne chemicals and particles arising from landfill operations."[68]

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[67] Letter from Bill Hunter to C. D'Angelo, July 28, 1998, p. 2.

[68] Bertell/Dixon Report April 2, 1998 p. 39.

8.3.9.4.1 Recommendations

1. ***Add fine particulate monitors to the air quality monitoring program. Specifically, PM2.5 monitoring should be included.***
2. ***The design of an appropriate network and approach for air quality monitoring should be developed in consultation with the CLC.***
3. ***Consideration should be given to locating a PM2.5 monitor within the nearby community to demonstrate the differences in dust levels measured at the property boundary of the site and within the community. This monitor could be located in different areas for six month to one year periods to determine particulate levels in specific locations.***

8.3.9.5 Dust and Quarrying Operations - MOE

It is impossible to separate the dust emissions from the East Landfill and the quarrying operation from overall potential air quality issues in the area. This is further complicated by ongoing final cover and landscaping operations on the West Landfill. These activities all add to the particulate levels in the area.

The current responsibilities of the MOE inspector are focused only on the East Landfill. There is also confusion because of different apparent responsibilities of MOE and MNR with respect to the environmental impacts related to the quarrying operations and the landfill however both impacts on the residents and the individual effects cannot be separated. This situation should be corrected. The MOE inspector responsible for the Taro site should also be reviewing and assessing dust control measures at the quarrying operation and the road. These are major dust sources.

8.3.9.5.1 Recommendation

The responsibilities of the MOE inspector should be modified to include reporting on and assessing the dust impacts of the quarrying operations and road traffic.

8.3.9.6 Particulate Emissions and Operations

The operations manual provides a general policy with respect to dust control. A more specific plan should be developed that addresses visible dust emissions (from landfill, quarrying and access roads). The use of a water cannon on the truck to assist in suppressing windblown dust from stockpiles and open areas should be considered.

The current East Landfill operation does take a pro-active approach to dust control (watering and wheel washing) but more attention should be given to re-active controls when visible dust emissions are occurring. This should not just be limited to the East Landfill, but should include the surrounding roads, the quarrying operations, and activities at the West Landfill.

8.3.9.6.1 Recommendations

1. ***The operations manual for the Taro site (including the quarry and roads) should be modified to be more explicit with respect to dust control through on-site watering. Specific attention should be given to visible observation and operator reaction to visible dust emissions.***
2. ***A water cannon should be mounted on the water truck to enable the operator to suppress visible dust emissions on stockpiles and other exposed areas that cannot be reached by the water truck.***

8.3.9.7 Heavy metals - Monitoring

Very small amounts of heavy metals (e.g. arsenic, cadmium) may be found within the waste materials accepted at the Taro site. The airborne dust from these wastes may contain heavy metals. MOE directed Taro to analyze 14 filter samples taken between Aug. 8, 1997 and Oct. 27, 1999. All samples show very low levels of heavy metals in the dust, with all samples of cadmium, lead and vanadium being within normal backgrounds levels and well below air quality criteria.

Since the level of metals will be dependent upon the type of waste entering the site, it cannot be assumed to remain constant over all future waste types. As such, metals monitoring should be continued.

8.3.9.7.1 Recommendation

Metals analysis of selected particulate filter samples should be continued by Taro. Selection of filters and target metals to be analysed should be undertaken by the MOE in consultation with the CLC.

8.3.9.8 Gaseous Compounds

Organic compounds are emitted from landfills through two mechanisms. The first is through the decomposition of waste material and secondly through the "evaporation" (volatilizing) of compounds in the waste. Decomposition is significant in landfills that receive municipal solid waste. At the Taro site, only a small fraction of the waste stream decomposes to produce gas. Even so, decomposition gases, such as methane, are generated within the site. As well, other compounds associated with the waste are volatilized and released to the atmosphere. A number of these gases can also be odorous and can lead to off-site odour impacts.

8.3.9.8.1 Methane

The migration of methane from landfills can, in some cases, cause significant problems. Methane is explosive. There are documented cases of methane causing explosions on and around landfills. In fact, roadwork near the West Quarry did discover methane that was migrating from the West Landfill. This has since been mitigated through the installation of a gas interceptor/collection system.

Methane migration will not be a problem with the East Landfill because the various liner systems will prevent methane migration. As well, as the site is capped, methane monitoring will be undertaken and continued. This will confirm that methane is not migrating toward the site boundaries.

8.3.9.8.2 Volatile Organic Compounds (i.e., Gases)

A number of studies have been undertaken by the Company and by the MOE to measure volatile organic compounds (gases) near and at the site. As well, the MOE maintains a permanent volatile organic monitoring station at Vickers Road and East 18th. The most recent results (summer of 2000) were provided by the MOE from their mobile TAGA unit. A number of key compounds are compared in Figure 6. The data are shown as a percent of MOE air quality criteria.

All of these studies have shown very low levels of volatile organic compounds. As well, measurements taken by Taro's consultants and MOE have been very consistent. For example, naphthalene was one of the highest measured concentrations. This was consistently found in all of the measurements. All off-site measurements are all well below MOE standards or criteria. The data from the Vickers Road site (not influenced by specific nearby sources), indicate that the levels found around Taro are comparable, if not lower for some compounds, than other areas within Hamilton.

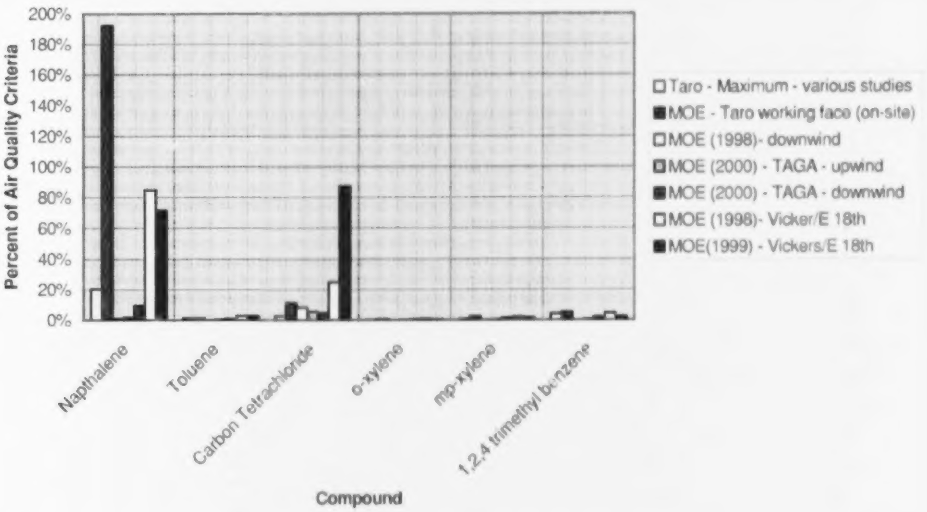
Regardless, volatile organic emissions should continue to be assessed.

Modifications to the Leachate Extraction Procedure will provide more detail and control over VOCs in the waste and should provide a better understanding of possible emissions, but new volatile organic compounds can be formed in the landfill at any point in its life.

8.3.9.8.2.1 RECOMMENDATIONS

1. ***VOC monitoring by the Company should be continued annually.***
2. ***The VOC monitoring should include a full (open) analytical scan to identify any changes to VOC emissions. This would be done by performing a full analytical scan and compound identification using a gas chromotagraphy – mass spectrometry analysis. This should be done by a certified laboratory familiar with this type of analysis.***

Figure 6
Volatile Organic Compounds



8.3.9.8.3 Odour

As with any wastes, the non-hazardous industrial wastes received by Taro can be odorous. Though Taro does an initial assessment of the waste stream, changes in the waste stream (either by the generator or in transport and handling) can change the odour characteristics of the waste. As well, since there is no scientific instrument to detect odour, odour detection is best done by the human nose. Unfortunately, this can be less than reliable. Odour detection by humans varies immensely and is easily influenced by such factors as masking by other odours, "fatigue" from exposure to odorous materials, and impairment through colds and flus. It will not be possible to eliminate the deposition into the landfill of some odorous materials. Current programs are in place to minimize accepting odorous wastes, but these can never be perfect, due to the factors discussed above.

Unpleasant odours from landfills can be viewed in communities as a psycho-social health concern as well as a nuisance as they act as a reminder of the landfill presence and some residents associate health issues with them. Although the odours expected from an industrial landfill site are much reduced compared with a domestic landfill site, some of the waste streams have significant odour. In Taro's response to the Nash neighbourhood development[69] Wayne Jackman indicated a number of "efforts underway at the site to deal with odour," including "an odour control procedure developed and reviewed at the

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[69] Letter May 20, 1998 Wayne Jackman to Steve Miazga Re: Secondary Plan Issues.

CLC level." The minutes record "As well, they (Taro) have advised that Professor Martin Marston of McMaster University has been retained to provide additional guidance on the matter of odours."[70]

There is regular documentation of odour complaints at the CLC, primarily through the MOE Inspector's report. This mechanism for monitoring is not ideal, as there are no technologies for assessing the subjective and variable perception of odour. Odours will continue to be an issue as development proceeds around the site. There has been no formal place on the CLC agenda for ongoing discussion about the effectiveness of the overall odour control procedure or of any particular odour abatement strategy. Such an evaluation could use sentinel sites (such as the high school) that are called on a regular basis for odour reports. While absence of odours in any community may not be a practical goal, achievable objectives could be established and monitored.

Taro has undertaken a number of pro-active actions, including odour sprays and quick burial of odorous wastes, but complaints will continue. We are suggesting a number of practices that can be improved and modified to further reduce odorous emissions.

8.3.9.8.3.1 RECOMMENDATIONS

1. ***More detailed procedures on assessing incoming waste (possible odour training of waste assessment staff at the generator and transfer sites).***
2. ***Tighter controls on accepting odorous waste. This would include further training and notification back to the generators and those assessing the incoming wastes, of odorous loads found in trucks or at the site.***
3. ***Use of other covering materials to reduce odour emissions from odorous wastes (e.g. clean soil). The use of temporary covers (e.g. uncontaminated soils) over exposed odorous wastes should be undertaken.***
4. ***Continue to be proactive in attempting to ensure that exposed leachate does not go anaerobic.***
5. ***The CLC should continue to consider odour management to be of ongoing importance and to identify goals/outcome indicators for the odour abatement program.***

8.3.9.8.4 Mitigation: Cover Materials

A number of the issues discussed above related to waste dust emissions (containing metals), volatile organic emissions and odours. There are two areas that these emissions arise from: the active working area, and uncovered wastes in inactive areas.

In municipal solid waste landfills, it is standard practice to cover waste daily with a soil cover to reduce blowing litter and to help mitigate odours. A similar practice should be undertaken at Taro to reduce the volatile emissions (including odour) and to minimize the amount of exposed areas that are waste. This will reduce the portion of waste particulate material that is emitted from the site.

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[70] Planning Department Report No. PLT98-29 Item 6 (a).

8.3.9.8.4.1 RECOMMENDATIONS

1. ***Temporary cover should be employed in locations where there is exposed waste, but where activity is not anticipated for 2 or 3 days. The cover should be non-waste material, preferably clean soil. This could be "stripped" back as an area once more becomes active.***
2. ***As well, the staging and operations of the site should be such that any bare areas (waste or cover) should be minimized. Vegetative cover should be established as soon as practical to minimize windblown dust erosion.***
3. ***Clean soils used for cover should not be considered as part of the waste tonnage for the site.***

8.3.10 Health Impacts and Implications

Contaminants have the potential to cause human health effects to persons living close to a landfill if the contaminants escape (now or in the future) en route to the landfill, or are discharged in leachate or air emissions after being deposited in the landfill.[71] As pointed out, the Taro East[72] has been required to, and to some degree, the West Landfill, do environmental monitoring of leachate, ground and surface water, combustible gases and air quality under the Certificates of Approval.

Health effects from landfills have been studied extensively in the literature. The focus in recent years has been the potential for quite subtle health effects from very low dose exposures and the recognition that exposures occur from multiple sources and varying distances and pathways. Linkage of specific health outcomes to exposures from specific point sources is an ongoing challenge.

The range of outcomes discussed in these health studies includes deaths, diseases such as cancers and self-reported symptoms such as headaches. It is important to note that there is no "sentinel" health outcome that can indicate problems with landfills. It is also crucial to recognize that the exposures measured can differ substantially with respect to the various potential contaminants involved. Most of the studies have used a crude measure of exposure such as residence or proximity to a landfill. Some have used environmental monitoring data to assess exposure. None of the studies reviewed by the panel used landfill sampling or biomarkers as a measure of exposure.

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[71] In addition to health effects from exposure to contaminants, particularly among nearby residents or other affected members of the community are exposed to potential health effects from the uncertainty associated with the siting process (Wakefield and Elliot, 2000), or from the operation of the landfill site itself (Neutra 1991).

[72] Schedules C, D, E, F, G.

A recent review (Vrijheld, 2000) concludes:

> Although a substantial number of studies have been conducted, risks to health from landfill sites are hard to quantify. There is insufficient exposure information and effects of low-level environmental exposure in the general population are by their nature difficult to establish. More interdisciplinary research can improve levels of knowledge on risks to human health of waste disposal in landfill sites. Research needs[to] include epidemiologic and toxicologic studies on individual chemicals and chemical mixtures, well-designed single and multisite landfill studies, development of biomarkers, and research on risk perception and sociological determinants of ill health.[73]

Health assessments consider the exposures themselves (sources, constituents, pathways), the populations at risk of exposure and the potential or reported health effects associated with the exposures and populations.

Environmental impact assessments are done prior to approval of any new project that could harm the environment. The health component of an environmental assessment typically uses mathematical modeling and toxicological/epidemiological evidence where available to predict the probability of health effects from exposure to contaminants expected to be released from the planned site. Health Canada has developed a set of draft guidelines to enhance the role of health assessment in the EA process.[74]

As a component of the EA process, Taro was required to "undertake a long term study of sources of potential health impacts and develop a health impact prevention programme." Taro hired CanTox, a risk assessment consultation group who consulted widely with the EA Study Group, reviewed information from the West Landfill waste stream and effluent and produced an extensive assessment of the potential health risks associated with the predicted exposures. Their thorough review and analysis revealed that the only health risk predicted was the possibility that "some minor respiratory irritation may be experienced by the most sensitive individuals if they are present on or directly adjacent to the Taro property under conditions favourable to formation of fugitive dust emissions."

Ongoing health assessment once a project has been approved is a newer field. Health Canada[75] is investigating recommendations for prospective data collection for monitoring purposes.[76]

Following consultation with the Medical Officer of Health, the EA Study Group negotiated (through their lawyer, Harry Dahme) a Schedule ("I"[77]) for ongoing health risk assessment which would review the monitoring results, review the most recent literature and revise predictions. This Schedule is considered a component of the Terms and Conditions of Approval under the Environmental Assessment Act.[78] Even though it is not included in the CofA it is considered legally binding by the MOE. The Company has complied with this Schedule through a continued contract with CanTox.

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[73] Similarly, a review of the literature pertaining to the impacts of landfills on vegetation revealed that there are very few studies with a focus on the impacts of landfill effluents on the surrounding environment. This is due in part to the fact that there is little consensus in the research literature on plant responses to landfill effluents as the phytotoxicity of many types of effluents is not well understood (Shrive et al., 1994).

[74] Davies and Sadler (1997 pp. 30-31) present a table of different methods for assessing health effects with their strengths and weaknesses.

[75] http://www.hc-sc.gc.ca/ehp/ehd/oeha/tech_report.htm.

[76] Canadian Handbook on Health Impact Assessment DRAFT Volume 3 Chapter D p. D17.

[77] Schedule I "The Community Health Impact Prevention Programme (the "Programme) to be initiated and conducted by the Company in consultation with the CLC and the Medical Officer of Health of the Regional Municipality of Hamilton-Wentworth ("MOH").

The Panel recommends that Schedule "I" be considered equivalent to the Certificate of Approval for monitoring purposes.

Moreover, in order to permit systematic review of all monitoring activities. ***The Panel recommends that a comprehensive monitoring protocol be developed by the MOE with input from the CLC and the Company's risk assessment experts. The protocol would serve as a template for reviewing all of the individual monitoring schedules in order to make decisions about adding or removing substances.***

This protocol should be reviewed at least annually in light of new information including updates from Health Canada, ATSDR and other relevant parties.

CanTox has reiterated their predictions in each of their annual reports. In their June 2000 report CanTox stated: "The results of the 1998 surface, water, ground water and air quality monitoring programs at the East Landfill are in accordance with assumptions that were made in the Community Health Assessment Study; thus, the conclusions of this study remain valid and unaltered."[79]

Some members of the CLC have expressed concern that the risk assessment approach does not constitute a "hands on" health study and are still worried about the potential for health effects, past present and future. Some members of the CLC have continued to request a health study and, on advice of their own consultants, have requested the inclusion of biomarkers.

The Panel recognizes the continued concerns of the community about current and future health issues. The Panel has made a number of health protection recommendations to improve the contaminant monitoring protocol to ensure full and updated characterization as well as to further reduce the potential for the escape of contaminants. These are detailed in the following sections:

8.3.10.1 Asbestos

Asbestos has been of particular concern as it is a substance that can be harmful to health and requires appropriate disposal. Concerns about asbestos in the landfill have been raised by the CLC,[80] the environmental inspector[81] and in the Bertell/Dixon report.[82] Asbestos is considered a non-hazardous waste in Regulation 347 and therefore is eligible for disposal in the Taro East Landfill. There was concern early in 1999 that some asbestos had been generated from outside of the Region.[83]

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[78] Item 8 Long Term Study of Health Impacts: Taro should undertake a long term study of sources of potential health impacts and develop a health impact prevention programme in accordance with the Terms of Reference set-out in the Attachment, headed Schedule I, to the letter of May 9, 1996, from Gowlings to the Minister."

[79] CanTox June 2000 Section A Taro 1999 East Landfill Annual Report, p. 25.

[80] Memo May 15, 2000 p. 7 question #19.

[81] Brad Farnhans summary report for panel.

[82] Bertell/Dixon Report, April 1998, pp. 7-8.

The landfill has received asbestos since its opening but it is predicted that the amount will decrease over time as the local area exhausts its generation of asbestos waste through other abatement methods such as encapsulation.[84] The Panel investigated the concerns about asbestos to identify if air or dust-fall monitoring could pick up non-compliance with the asbestos handling regulations. There are no current methods for accurately measuring asbestos fibres in outdoor environments. The best way to reduce the potential for exposure is through appropriate management and auditing of the asbestos handling procedures.

The Panel recommends that the on-site inspector should inspect and report, on a regular basis, compliance with the asbestos handling procedures (Regulation 347, Section 17) and the service area. Non-compliance with these procedures should be acted upon immediately.

These health protection recommendations could fit within the Community Health Impact Prevention Program set out in Schedule "I."

8.3.10.2 Health Committee

The Panel recommends a process for raising and resolving ongoing health concerns through an adequately supported sub-committee of the CLC.

There are a number of Ontario examples of health expert involvement in landfills (such as Brock West)[85] and other environmental "hot spots." For example, a Health Studies Advisory Panel has been proposed for the Port Hope community.[86] This Panel would "formally consult with the community, evaluate information from current studies and make recommendations on the need for and direction of future studies."

The Taro Landfill Health subcommittee would build on the existing Community Health Impact Prevention Programme as defined in Schedule I and provide the CLC with access to and input from individuals with health expertise at the Region,[87] including academic health researchers, the local health community, and the Company's health risk assessment experts (currently CanTox).

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[83] Letter from Brad Farnham in 1999 Annual Report.

[84] Asbestos Tonnage disposal at Taro[84]

	1997	1998	1999	Total
Dofasco	31.59	667.05	14.24	712.88
Philip	270.18	9824.36	82.39	10176.93
Other H-W	2642.13	475.2	826.7	3944.03
Total	2943.9	10966.61	923.33	14833.84

(source: Personal communication Wayne Jackman July 18, 2000)

[85] Brock West Landfill Site, Public Health Assessment March 1996.

[86] Canadian Nuclear Safety Commission News Release August 22, 2000.

[87] Additional health unit resources for this committee will need to be negotiated. The Health Hazard Investigation Program in the Mandatory Health Programs and Services Guidelines requires a health department to consult with and provide advice to the community about health hazards when such health hazards are identified. Other health hazards in the Region may take priority for the use of limited resources.

The members of this sub-committee would be charged with interpretating and communicating monitoring results, reviewing and recommending health protection measures and investigating health concerns.[88] This sub-committee has the potential to be a focus for resolution of conflictual situations about waste (Cole, 1996) but would require commitment from all parties to ensure that any health issue would not be used as a tool in the conflict.

8.3.10.3 Health Study

The Panel considered very carefully the CLC request for a health study and consulted with a number of experts, key contacts (including community members with health concerns) as well as the literature.

The ATSDR (Agency for Toxic Substances and Disease Registry), the US agency charged with assessing health risks from toxic substances, has produced a guidance document to consider in designing health studies for communities that might be exposed to harmful substances.[89] The document suggests that

> When the decision to conduct a health study is being considered, the following criteria should be used to determine the type of health study:
>
> - Characterization of environmental contaminants by type, media and concentration levels.
> - Documented evidence of human exposure at a level of concern.
> - Level of current knowledge about the relationship between exposure and specific adverse health outcomes.
> - Documented excess of an adverse health outcome, when known.[90]

Based on the first three points, the Panel concluded that there were no strong reasons to recommend a health study. The characterization of the incoming waste and outgoing leachate and air has been done by the Company (primarily) and by the MOE. As discussed in this Report, there is currently no documented evidence of human exposure at a level of concern.

CanTox has continued to annually review current knowledge and has predicted that there will be no specific health outcomes which would require further investigation.

On the final (ATSDR criteria) point, the Panel felt there was a lack of reliable information or systematic documentation of adverse health outcomes. Health outcomes of concern can have multiple causes and much expected geographic variability.

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[88] For example, if proximate residents had specific health concerns, the health sub committee could provide advice and resources to the personal physician for the investigation.

[89] http://www.atsdr.cdc.gov/HS/gd1.html The document has a section on "Considerations for Proceeding With A Health Study" listing the following factors: "public health significance, community perspective and involvement, scientific importance, ability to provide definitive results, resources, contribution to program goals (superfund), and authority and support."

[90] ATSDR does not define "excess" in this statement.

Documentation of a number of local health outcomes such as cancer around a landfill is not sufficient evidence that these problems are landfill related.

The concept of "excess" outcomes occurs when a community beside a landfill is compared with another similar community. If there is more of the health outcome of interest (such as cancer) in the community close to the landfill, then further study is required to identify if this difference occurred by chance (statistical testing); or whether other factors (such as age, gender, occupation, lifestyle, socioeconomic factors etc.) could explain the observed "excess." A recent study of cancer in the Port Hope community is an example of this kind of environmental investigation.[91]

Irrespective of the fact that the monitoring results demonstrate only low levels of exposure, the Panel was informed of a number of health concerns expressed by members of the community. Moreover there are still outstanding questions about historical exposure from the West Landfill and uncertainty as to whether monitoring and model-based predictions can comprehensively assess all aspects of health, including psychosocial health.[92]

There has been no estimation of the size of the exposed population in order to calculate whether the necessary sample size is available to establish if "excess health outcomes" are present. No comparative study of the health status of the community has been done to identify if "excess health outcomes" have occurred.

The Panel is recommending that a health study program be undertaken in conjunction with other research to permit comparisons with people living in other parts of the Region and country. Linking with an ongoing research program ensures that the results can be properly interpreted. This can also reduce costs. The results of this study program cannot establish whether a causal link exists between the landfill and health outcomes, but it could indicate whether there was a difference in the health status of the community living close to the landfill compared with similar populations who were not living beside the site.

The health study program could be designed, for example, to tie into one or both of the following proposed studies:

- An analysis of historical mortality and disease information over the past 15 years within the Region. This study is currently ongoing and funded by the Health Canada Toxic Substance Research Initiative.[93]
- An assessment of children's respiratory health linked with air quality. This study would be able to investigate if there was any impact of fine particles[94] and other local air pollutants on children's lung health. This study is a follow-up of an international

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[91] Cancer Incidence in Port Hope 1971-1996 –this report was provided to the panel by William Hunter, Ministry of Health.

[92] Report of the Expert Panel Workshop on the Psychological Response to Hazardous Substances September 2000.

[93] M. Jerrett, "Air Pollution, Environmental Equity and Health: A Spatiotemporal Analysis." Funded by the Toxic Substance Research Initiative of Health Canada (1999-2002).

[94] Monitoring of fine particles is recommended in the Air Quality section.

assessment of air quality's effects on children's health.[95] This study could include assessment of clinical lung function as a biomarker of effect. It might also consider psychosocial concerns.

The health study program will need to be developed by the health sub-committee and funding negotiated with the CLC. The Company has indicated its support for the health program but should not be expected to fund it in its entirety. The MOE should negotiate the funding sources once a budget is prepared.

8.3.10.4 Ecosystem Health and Integrity

The Panel has been asked to consider the impacts of the Taro operations on the local ecosystem. In our view, any impacts would be related to emissions of contaminants from the landfills or the quarry via the following:

- air;
- surface water;
- groundwater.

8.3.10.4.1 Air Impacts on Ecosystem Health

The relatively low levels of air quality impairment caused by the Taro operations (compared to the heavy industries below the escarpment in the City of Hamilton) have led us to conclude that any air impacts on ecosystem health will be minor by comparison, and would not be measurable.

8.3.10.4.2 Surface Water Impacts on Ecosystem Health

There are currently no surface water impacts on local ecosystem health because there are currently no surface water discharges from the Taro properties. In the future, stormwater discharges from the landfills will be discharged to tributaries of Davis Creek. The Panel has recommended that before any surface water discharges take place, the planned discharges (including all monitoring and contingency plans) should be reviewed by the CLC.

8.3.10.4.3 Groundwater Impacts on Ecosystem Health

The Taro operations have caused a salinization of groundwater downgradient of the landfills (as discussed in the section of the report which deals with groundwater issues). The only place where this groundwater salinization could have any impacts on ecosystem health is where groundwater discharges along the Niagara Escarpment, assuming that the salinized groundwater eventually travels as far as the escarpment and discharges there.

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[95] Habbick, B.F., Pizzichini, M.M., Taylor, B., Rennie, D., Senthilselvan, A., and Sears, M.R.. 1999. Prevalence of asthma, rhinitis, and eczema among children in 2 Canadian cities: the International Study of Asthma and Allergies in Childhood. *Canadian Medical Association Journal* 160(13):1824-1828.

There is currently no visual evidence of any impacts on the health of vegetation near the springs. The Panel has recommended (in the Groundwater section of the report) that water quality at springs along the escarpment be monitored on a quarterly basis.

8.3.10.4.4 Recommendation

The Panel further recommends that if the escarpment spring monitoring shows impacts which may be related to the Taro operations or if there is visual evidence of impacts on the health of vegetation near the springs, that a more detailed study of the impacts of the spring discharges on local ecosystem health should be designed (in consultation with the CLC, in particular with the HRCA) and carried out by Taro.

8.3.10.5 Land Use Planning Issues

The Panel has had many submissions from residents in the vicinity of the Taro landfills who have expressed the opinion that landfills should not have been approved so close to residential developments.

Also, many residents have indicated that in their opinion no further housing developments should be approved near the East Landfill while it is in operation. Yet the Panel has heard that in the area around the East Landfill the population is expected to double within the next decade or so.

Further, the Panel has been asked by the City of Stoney Creek whether there is any reason that the proposed sports facility on the lands northwest of the Taro West Landfill should not be built.

Although the Panel members do not have a background or expertise in land use planning, based on the areas of expertise of the Panel, it can offer the following advice related to this issue:

- The Panel has not identified any obvious risks to human health which might be posed by the East Landfill and which might preclude development in the vicinity of the landfill.

- Any landfill brings with it a series of nuisance impacts such as noise, traffic, odour, dust, visual impacts etc. and these nuisances can cause aggravation and stress to those who are exposed to them. People who are considering purchase of a home in the area should be aware of the presence of the landfill, and of the potential for such impacts.

  Such nuisance impacts can also be expected to occasionally occur in the vicinity of the proposed sports facility.

- The Panel has found neither environmental nor health reasons which preclude the construction of the proposed Heritage Green Community Sports Park on the lands north of the Taro West Landfill, provided that all of the Terraprobe Limited[96] report recommendations are implemented.

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[96] Report prepared by Terraprobe Limited for the City of Stoney Creek, March 10, 2000.

The Panel recommends that the CLC consider whether it wishes to take a more active role in local planning issues related to development around the landfill, including the following:

1. ***Making a recommendation on whether the City should implement a mechanism to ensure that people who might purchase homes or properties within 1 km of the landfill will be made aware of the presence of the landfill, and of the potential for nuisance impacts as outlined above;***
2. ***Participating in the public input on decisions regarding future developments within 1 km of the landfill;***
3. ***Getting involved in the review of the impact studies done by developers, for development proposals pertaining to areas within 1 km of the site.***

8.4 ARE APPROPRIATE PLANS IN PLACE TO SAFELY CLOSE THE SITE AT THE END OF ITS OPERATION?

The safe closure of a landfill is guided by the plans and procedures included in the landfill's "Closure Plan." This plan is typically prepared a few years before closure. Conditions 79 and 80 of the C ofA require the preparation of such a plan at least 2 years before site closure, in consultation with the CLC and HRCA. The Panel is satisfied that the landfill can be closed safely with the implementation of these conditions.

8.5 ARE SUFFICIENT FUNDS IN PLACE TO ENSURE THE LONG TERM PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT?

8.5.1 Financial Assurances

The Panel heard repeated questions from the public about whether adequate financial assurances are in place to cover the costs of closure and long-term care (likely over hundreds of years) of the East Landfill.

The Panel does not have the background or expertise to properly address this question, but the Panel notes that as per Condition 88 of the Certificate of Approval the financial assurances package is reviewed every three years.

The Panel recommends that the CLC participate in the next 3-year review process, and that it commission an outside reviewer(costs to be covered by Taro through the CLC budget) to review the financial assurances package to ensure that it is adequate.

In particular, the Panel recommends that any third-party reviewer should carefully evaluate the costs specified for the following issues:

- *site closure;*

- ***long-term leachate treatment (cost estimates for this item may be low, given current costs for leachate disposal and treatment);***
- ***long-term site monitoring;***
- ***implementation of post-closure contingency plans.***

8.5.2 The Role of CLC

The ongoing monitoring of the Taro Landfill requires continued involvement of the CLC. For the CLC to perform this task effectively, it will need some restructuring.

The CLC was set up (as required by the C of A for the East Landfill) without benefit of any guidelines or formal assistance from the MOE in establishing its composition, structure or procedures. In a thesis evaluating the effectiveness of bodies like the CLC, Yacoumidis (1998: 8) cites the following theoretical benefits of public participation in the siting process at landfills:

- The promotion of trust and credibility between residents, the proponent and government regulators
- The education of resident participants about the proposal
- The empowerment of residents and the community
- The reduction of residents concerns about the landfill proposal
- A reduction in resident opposition to the landfill proposal
- The increased likelihood of successful siting
- Better decision-making resulting in an improved landfill design and operation (i.e., monitoring and impact management of off-site impacts).

Public participation in the post-siting process (once the landfill is in operation) can continue these benefits. This is the rationale for having CLCs. But establishing a mechanism for public participation is no guarantee of success in achieving these theoretical benefits. If the process is poorly designed, or if it fails to address the community's key concerns, it may actually exacerbate tensions and conflicts. In order to assist CLCs in achieving these potential benefits, ***The Panel recommends that the MOE develop guidelines for the establishment and operation of CLCs.***

In his report on community attitudes to the Taro East Landfill Colin Isaacs[97] recommended a number of changes to the way the CLC operates in order to improve its effectiveness.

The Expert Panel agrees that improvements are needed. In our opinion, a well-functioning CLC which is adequately funded by Philip and adequately supported by MOE will be better able to reflect public concerns, review ongoing monitoring information, and raise and resolve key issues about site operations.

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[97] "An Urgent Need for Real Communication," July 1999.

Accordingly, our recommendation is to increase the ability for the CLC to carry out its vital tasks by adopting the following changes:

a) Expanded membership

The CLC should have additional representation from the HRCA, and a health expert.

b) More Active Role for MOE

The Panel recommends that MOE play a more active role in future CLC meetings, for example by reviewing and commenting on the annual Report; having IEB representatives speak to the CLC on enforcement issues and so on.

c) Health sub committee

The Panel recommends establishment a health sub-committee of the CLC which would be a venue for discussions of ongoing health concerns. This subcommittee is described in the health section.

d) Professional chair/facilitator

The current CLC Chair has faced the impossible task of trying to both chair the meetings and to reflect the concerns of local residents. In its initial phase the CLC had co-chairs (one nominated by the Company, the other by the citizen members) but this arrangement was discontinued after the Company-appointed co-chair moved to a new job.

In order for the CLC to function as a forum for open discussion in which all parties are heard and respected, we recommend the appointment of a neutral chair/facilitator (i.e., someone not associated with any of the parties represented on CLC). Any costs associated with this position should be covered by the Company funded on a similar basis to the full time MOE landfill inspector.

e) Citizens' Coalition

If citizen members of the CLC wish to form a group and/or hold meetings outside of the formal meetings of the CLC to allow members of the community to meet with them and give them input and direction, then modest funding should be provided to cover any costs associated with notice of meeting and room bookings.

f) Staffing from the City

As is the practice with some other CLCs, secretarial support for the CLC and its sub-committees should be provided by the City. In addition to providing a staff person to record the minutes of CLC meetings, the City should also arrange to send out minutes, agenda, and any supporting documentation to CLC members; give public notice of meetings; and make the necessary room arrangements.

g) Respect for the Integrity of the CLC Process

The CLC should operate in as open and transparent manner as practicable. Members of the CLC should address their concerns about the matters within their mandate to each other and avoid taking issues to the media or into litigation before allowing for discussion and response from fellow CLC members. Public involvement through questions and answers should follow the guidelines set out in the current CLC Terms of Reference.

h) Focus expands to entire Taro operation (but not other Philip operations)

The current mandate of the CLC is to review the operations of the Taro East Landfill. This mandate should be expanded to include the West Landfill and the East Quarry. Other activities or operations of Philip, unrelated to the Taro sites, do not fall within the CLC mandate and attempts to introduce discussion of such extraneous issues into the business of CLC should be ruled out of order.

i) Consensus decision making

CLC should aim for consensus in all of its decisions, but decide by majority vote when this is not possible. The chair/facilitator chosen should be familiar with the principles and practices of consensus decision making, and should guide CLC members in learning about their responsibilities within such a process. Reasonable efforts should be made to address the valid concerns of all members before reaching decisions.

j) Simplified process for reviewing data and interpreting results

Efforts should be made to ensure that all data and technical reports are presented in clear terms that are comprehensible to non-experts. Data should also be put into context so that the test results for samples taken by different parties are compared.

In future, all independent sampling completed by the MOE of leachate, groundwater, surface water and air quality should be presented to the CLC in a manner that clarifies its relationship to other data. This information should be provided to the Company for inclusion and comment in its annual monitoring report.

k) Reasonable funding for citizen expert consultants to review Annual Report

Funding should be provided to the citizen members of CLC to hire their own technical consultant(s) to review the Annual Report. The selection of specific consultants should ideally be reached through consensus of the entire CLC, but if consensus can not be reached then the choice should be left to the citizen members. Funding required for such consultants will be high in the first year (likely on the order of $20,000), but should decrease after that as the consultants become familiar with the site and as issues get resolved. This funding should not be used for legal services or any other purpose other than technical review and comment.

Funding should only be provided for a given consultant once a work plan and budget has been submitted and approved by CLC. At year's end, proper accounting for the monies spent should be submitted to the CLC by the citizen members.

8.6 IS MOE UP TO THE TASK OF PROTECTING PUBLIC HEALTH AND THE NATURAL ENVIRONMENT?

The Terms of Reference which established the Expert Panel acknowledged that the MOE had come under severe criticism by members of the public for its handling of the issues related to the Taro landfills. The Panel has found that there are many reasons why some members of the public are angry with the MOE.

Some of MOE's critics point to apparent inconsistencies in its position on some key issues. Is there hazardous waste in the East Landfill? The MOE appears to have equivocated on this crucial question. Did the Company break the law? Again the MOE appears to have changed its response to this question. Was the Ecosafe process reviewed and approved by MOE? Even IEB Investigator Gordon Robertson had difficulty answering this question. Would the MOE have known about the CyanoKEM wastes without the informal investigations of a few private citizens? These and other questions have contributed to public doubts about MOE's ability to deal adequately with the issues raised by the Taro landfills.

Other critics point to cutbacks in MOE funding and personnel suggesting that: "budgets and staff have been cut"; "there is high staff turnover"; "labs have been closed"; "regulations weakened through non-enforcement"; "programs abandoned."

The Panel was informed of concerns about "officially induced error"[98] and a weakening of enforcement in favour of abatement – which one critic described to the Panel as a form of MOE collaboration with companies that are out of compliance.

MOE's "Six Point Action Plan" is in part a response to these criticisms and complaints. A copy of the plan is provided in Appendix A. That plan includes a commitment to bring regulations concerning hazardous waste more in line with U.S. regulations.

The Panel endorses that commitment and recommends that the MOE continue to proceed along these lines. Specifically, this will require the following:

1. ***Adoption of the "cradle to grave" onus of responsibility on the generator of waste to ensure proper disposal.***
2. ***Review of the delisting procedures and requirements to maximize compatibility between Ontario and regulations in bordering U. S. states.***

The Panel also recommends the following:

1. ***The MOE thoroughly review the requirements regarding financial assurances concerning both remediation or closure of a landfill (in the event of an emergency); and long-term maintenance and monitoring after normal closure of a facility.***

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[98] This phrase was used by MPP Brad Clark to refer to a Ministry's practice of implicitly encouraging non-compliant behaviour by failing to enforce – or in some cases properly understand or apply – laws or regulations.

2. ***The MOE review sampling procedures for stabilized waste and develop a protocol that allows an assessment of the mixing on a reasonable scale.***[99]
3. ***In future, MOE should present all its independent sampling of waste, leachate, groundwater and air quality to the CLC in a manner that clarifies its relationship to other data. This information should also be provided to the Company for inclusion and comment in their annual monitoring report.***

The panel was pleased to learn that the MOE has reviewed its EA process and made two significant changes to the Act. The first is the addition of a mandatory consultation process by which a proponent must now come into the EA process with Terms of Reference for a proposed project/facility and that have been developed in full consultation with the public. In addition, once the MOE and Minister have reviewed the ToR, the public can then also provide feedback for further recommendations. The second change to the Act concerns mediation. Under the new Act, mediation can take place at any time in the process. Anyone (public, proponent) can ask the Minister to request mediation between the parties involved. This feature only works, however, when both sides agree to it. The minister cannot enforce mediation.

The cumulative effect of these changes to the Act is that some of the control has been given to the general public to influence the process by being involved in the process at every stage.

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[99] Michigan regulations call for officials of the Department of Environmental Quality (MDEQ) to take a single "grab sample" to test the acceptability of such wastes. The practice related to waste destined for the Taro landfill has been to take samples from several parts of a load and mix them together prior to testing. The results of the Ontario procedure depends on (a) the size of the grab samples, (b) the number of brag samples, and (c) the level of mixing of the grab samples. Arguably the Ontario procedure makes it more likely that a poorly mixed load will pass the test because any "hot spot" samples will be balanced by sample results from other parts of the load. On the other hand a singlegrab sample may may also be misleading since it may either miss unmixed "hot spots" or, if too small, not fairly represent the waste (e.g. may show a hot spot due to a very local variation in mixing when in fact the waste is reasonably well mixed).

Section 9.0

Further Lessons from Taro

The Expert Panel's has adopted a forward-looking perspective on the issues related to Taro. Instead of reviewing what has transpired in the past in order to point fingers and assign blame, we have drawn on our retrospective analysis to identify constructive steps that can be taken in the future to ensure the proper operation of this facility, continued protection of human and ecosystem wellbeing, and the rebuilding of public trust and confidence. With these objectives in mind, it is nevertheless useful to review how MOE has responded to the issues and concerns raised about the East Landfill.

When the CyanoKEM issue was first brought to MOE attention, MOE sent a letter dated October 9, 1998 (the "Percy letter") informing the Company that "your current waste handling procedures are being done in violation of Regulation 347 of the Environmental Protection Act." On October 14, the matter was referred to the IEB, which commenced its investigations a few days later. Months after these investigations were concluded in February 1999, the director of IEB, Wilfred Ng, sent the Company a letter dated September 17, 1999 contradicting the Percy letter, stating that it was however "written in good faith and reflected the widely prevailing understanding in industry as well as the Ministry of the applicable law." This Ng letter is an acknowledgement that MOE did not properly understand the applicable law. Specifically, the "Registration Guidance Manual for Generators of Liquid Industrial and Hazardous Waste" did not have the force of law, despite MOE's assumption to the contrary.

IEB Officer Robertson's report contains a number of observations critical of MOE regulations and practices, and recommends changes both in the general regulations and also with respect to the particular operations related to Taro. He was very critical that the CofA for several of the waste processing facilities involved in handling the CyanoKEM wastes were "poorly worded, confusing and vague with respect to site processing," and in effect gave "open approval" for handling any kind of waste, including all types of hazardous waste.[100] This concern was echoed in the June 2000 MOE report on the "audit" of Taro, which stated that "some of the conditions in the Certificate of Approval [for the 52 Imperial St. facility] are not clear and become problematic for a provincial officer to enforce ...."[101] ***The Panel recommends that MOE review its practices with respect to the issuing of Certificates of Approval to ensure input from both IEB and field officers with respect to the clarity and enforceability of the conditions contained in these documents.***

To MOE's credit, several of the problems identified by Officer Robertson and others have been addressed. The Waste Generator's Guidance Manual now does have the force of law. **(See O.R. 460/99)** The CofA for Imperial St has been amended, and one condition required the Company to provide an independent assessment of the Ecosafe process.[102]

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[100] "Taro East Quarry Waste Disposal Site. Report on Alleged Receipt of Hazardous Waste Generated by CyanoKem Inc. of Detriot Michigan." (MOE, n.d.) pp. 21, 9.

[101] "Ontario Ministry of Environment. Hamilton District Office. Taro East Landfill Environmental Audit and PSC Waste Processing sites Environmental Compliance Inspection Summary." (June, 2000) p. 9.

The Hamilton District Office of MOE also undertook its own "comprehensive environmental sampling and inspection program" of the Taro operation beginning November 9, 1998. Sampling ended on April 1 1999 after a total of 403 samples had been taken. This total included 244 samples of waste and 159 samples of leachate, groundwater, and air. This "audit" revealed only two relatively minor non-compliance issues.[103] It generally supported the monitoring results reported by the Company.

The amount of independent sampling MOE carried out during the "audit" far exceeded normal sampling procedures. As part of rebuilding public trust and confidence, ***the Panel recommends that MOE continue its more frequent sampling of leachate, air quality, and incoming waste and report the results of this sampling to the CLC as recommended elsewhere in this Report.***

The Panel is of the opinion that provided that adequate resources (i.e., staff time and funding) are made available, that the MOE is able to protect public health and the environment at this and other landfills. The recommendations provided in this report should enable the MOE to better carry out these tasks, and the Panel urges the Minister to implement our recommendations and to make available to the MOE the resources necessary for their implementation.

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[102] This is not exactly what Gordon Robertson recommended. His second recommendation stated, "A thorough technical review and evaluation of the Ecosafe process should be conducted **by qualified Ministry experts.**" [emphasis added] It is not clear to the Expert Panel whether the MOE has the required expertise to undertake such a review. What has transpired is a review by a consultant selected by the Company, with the MOE (and the Expert Panel) then given an opportunity to review and comment on the consultant's report. At the time of writing this Report, the MOE had not completed its review.

[103] The Audit Report did note that one truckload of hazardous waste was received and irretrievably deposited in the landfill.

Section 10.0
Conclusions

The following conclusions represent our collective opinion on the issues examined by the Panel. We believe that these conclusions address, in a comprehensive way, the current issues of concern for the Taro East (and West) Landfill.

1. With respect to the CyanoKEM controversy, the Panel accepts the conclusion of the MOE investigator (Mr. Gordon Robertson) that the company did not break the laws of the Province of Ontario in its acceptance of wastes from CyanoKEM.

2. The Panel has not found any evidence to suggest that significant or widespread dumping of hazardous wastes has occurred at the Taro East Landfill. The Panel notes that the MOE Audit Report records that one truckload of hazardous waste was received and irretrievably disposed of in the landfill. The landfill's leachate chemistry strongly suggests that little if any hazardous wastes have gone into the landfill, and that any such wastes that may be present are chemically bound within the landfill's wastes.

3. The Panel is aware that at least one MOE reviewer has had concerns about the ability of the Ecosafe process to stabilize wastes. However, based on the data in the consultant's report (which is currently being reviewed by the MOE), the Panel has concluded that the company's Ecosafe process for stabilizing hazardous wastes is an effective and very useful technology for the treatment of leachate toxic wastes. The Panel does, however, have some concerns about the unproven homogeneity of the final product and the efficacy of the mixing technique used.

4. The Panel is aware that there is great public concern about the issue of whether stabilised waste deposited in the East Landfill was not uniformly mixed; or whether the landfill contained a small quantity of what would otherwise (were it not such a small quantity), be classified as hazardous waste; resulting in the formation of "hot spots" which may now or in the future pose environmental problems. In fact, however, even in the event that hot spots are present in the landfill, problems are highly unlikely for the following reasons:

   - If the problem chemicals in a hot spot are chemically bound to the wastes with which they were landfilled and stay where they are (ie. if they are "immobile"), then there is no problem. They are inside a modern, well-designed landfill, which is as secure a place as any for the disposal of such chemicals.

   - If the problem chemicals become "mobile" as part of the landfill's leachate, then they will travel downward with the leachate (drawn by gravity through other wastes in the landfill). As they move through those other wastes (which will be quite different in composition from the hot spot), they will tend to get attenuated out of the leachate. Only in cases where the hot spot is massive or where there are significant quantities of other wastes in the landfill also containing the problem chemicals, will they **not** get attenuated. In those cases, they will be present in the leachate when it reaches the base of the landfill, but will be blocked by the barrier system, and collected by the leachate collection system. In those cases, however, sampling of the leachate will detect the problem chemicals. Once they are detected, any necessary measures to deal with them can be developed.

5. Ontario's hazardous waste regulations have already been significantly improved as a result of the scrutiny received in the case of the Taro East Landfill. Further changes have been announced and are scheduled to come into effect next spring.

6. The Panel has reviewed and accepts the current landfill monitoring paradigm, which focuses on screening the wastes going into the landfill and then focuses on monitoring the landfill emissions (gases and dust via air, and leachate via groundwater, collected leachate or surface water).

7. The Panel is of the opinion that it is currently generally not possible to sample wastes buried in a landfill and use the results of that sampling to conclusively determine whether hazardous wastes were deposited at the landfill. The reasons for this include the following:

   - The Panel is not aware of any regulatory protocols, standards, or guidelines in Ontario for conducting and evaluating the results of landfill sampling (including "deep core drilling"). In the absence of such protocols, standards or guidelines it is not possible to conclusively prove the presence or absence of hazardous wastes through landfill sampling.

   - The current definition of hazardous wastes includes an exemption for small quantities of materials that in larger quantities would be classified as hazardous. If testing of a landfill indicates that potentially hazardous materials are present, there is no way of telling if these materials got into the landfill legally (under the small quantities exemption) or illegally (violation of Regulation 347 and the landfill's Certificate of Approval).

   - Materials which have been buried in a landfill can undergo a series of physical, chemical and biological changes. As a result, in a few instances buried materials that did not test hazardous before going into a landfill may test hazardous later on. This would apply to all landfills, therefore a set of sampling results from several landfills would be needed to determine if any one landfill's samples were outside the norm. To gather such data would require that MOE develop protocols for sampling, testing, and interpreting the results.

8. The Panel does recommend that MOE study the advisability and feasibility of developing regulatory protocols, standards, or guidelines in Ontario for conducting and evaluating the results of landfill sampling (including "deep core drilling")provided that this review is set in the context of an overall review of landfill regulations, and that it takes account of the various other recommendations set out in this Report.

9. With respect to the protection of human and ecosystem health, it is far more important to know what is coming out of the landfill site than what is in the landfill.

Even if one hundred core samples were taken, they would represent only a minuscule fraction of the landfill's volume. By contrast leachate and emitted gas samples represent the whole landfill, and their analysis will indicate any hazard the landfill may pose to the citizens of Stoney Creek or to the ecosystem.

10. The Taro East Landfill has been well engineered. It has a barrier system which exceeds that required by Ontario Regulation 232/98. The barrier system consists of a primary leachate collection system, a 1 meter thick composite primary liner, a 0.5 meter thick hydraulic control layer, and a 1 meter thick secondary compacted clay liner over a groundwater collection system.

    The site will be operated as a hydraulic containment landfill after landfilling is completed. The Panel is confident that the design concept of the landfill is "state-of-the-art" with several layers of backup that can be relied upon if some component of the system does not work as intended. To date, the system is working as intended however there are a few ways in which the design can be improved (these are outlined in Appendix D of the Panel's report).

11. Leachate from the Taro East and West Landfills is generally comparable to that of other non-hazardous waste landfills. In particular it is generally comparable to both the Glanbrook landfill (which serves the City of Hamilton) and the Keele Valley Landfill (which serves the City of Toronto).

    The leachate quality data for both the East and West Landfills do not provide any indications of deposition of hazardous waste in either landfill. Given the level of public concern about the landfills, the Panel was pleasantly surprised by these findings.

12. Leachate from the Taro landfills can and should be treated at municipal wastewater treatment plants (WWTPs). Taro West Landfill leachate is currently treated at the Woodward Avenue WWTP in Hamilton. The Panel notes that this plant already takes leachate from other landfills in the Region.

    Taro East Landfill leachate is currently treated at a WWTP in Brantford, after being transported there by truck. The East Landfill leachate is not significantly different than the West Landfill leachate, and may also be suitable for treatment at the Woodward Ave. WWTP.

13. The Panel is concerned about plant by-passes at the Woodward Ave. WWTP, and has recommended that leachate be held back at the landfill(s) during by-pass events. The Panel also has a number of other recommendations regarding leachate treatment.

14. There is no sign that any leachate contamination from the East Landfill has reached the groundwater flow system beneath or downgradient of the landfill. The leachate barrier and collection system are functioning as designed, and are containing the East Landfill's leachate.

    Leachate from the West Landfill has caused groundwater contamination, and mitigation measures (containment wells) are in place and have been used to try to keep the zone of leachate contamination confined to the immediate area of the landfill. Nonetheless, degraded groundwater has been moving northwards from the area of the Taro East and West landfills since at least the early 1990s. The Company's consultants have argued that the groundwater degradation observed in downgradient areas (north of the landfills) was not due to escaped leachate from the West Landfill, but instead was a secondary effect of the pumping of the containment wells. This may well be true, but regardless of how it occurred, there is no question that there has been a significant degradation of groundwater quality downgradient (north) of the landfills, and that it was caused by the Taro landfill operations. This issue has not been adequately addressed to date, and the Panel's report provides recommendations on this issue.

15. The East Landfill has no surface water impacts in the vicinity of the landfill. All surface water is collected together with the leachate, and taken to Brantford for treatment. Surface water from the West Landfill is now collected and treated together with the landfill's leachate. Thus there are currently no surface water impacts in the vicinity of the West Landfill.

    The West Landfill and the East Quarry have, in the past, had significant impacts on surface water quality. In the future, stormwater discharges are proposed from completed portions of both the West and the East Landfills, and the Panel's report provides recommendations regarding these future stormwater discharges.

16. Dust emissions from the Taro operations are in keeping with the projections made at the time of the EA and are consistent with dust levels in other parts of Hamilton (both above and below the Mountain) The Panel has recommended improvements to the dust suppression and dust monitoring programs for the Taro operations. M

17. Methane and volatile organic chemical (VOC) emissions are not a problem at the East Landfill. As an extra precaution, however, the Panel has recommended VOC monitoring continue at the East Landfill.

18. Landfill odours pose an ongoing nuisance to the surrounding community. The Panel has recommended measures to try to minimize odour complaints from the surrounding community.

19. The Panel has not identified any obvious risks to human health posed by either the East Landfill or the West Landfill. Nonetheless, the Panel was informed about a number of health concerns expressed by members of the community.

    The Company (in its Ten Point Plan) has already committed to supporting an independent health study. The Panel supports such a study being carried out as part of the work of the new health sub-committee of the CLC and has indicated some possible approaches to undertaking a health study.

20. The Panel has not found any evidence to suggest that the current Taro operations are having any off-site impacts on ecosystem health.

21. Any landfill (and the Taro East Landfill is no exception) brings with it a series of nuisance impacts such as noise, traffic, odour, dust, visual impacts etc. and these nuisances can cause aggravation and stress to those who are exposed to them. The

Panel feels that people who are considering purchase of a home in the area should be aware of the presence of the landfill, and of the potential for such impacts.

22. Nuisance impacts can also be expected to occasionally occur in the vicinity of the proposed sports facility. The Panel notes that a similar proximity to the West Landfill did not prevent the successful development of the Valley Park facility on Paramount Drive.

    The Panel has found neither environmental nor health reasons which preclude the construction of the proposed Heritage Green Community Sports Park on the lands north of the Taro West Landfill, provided that all of the Terraprobe Limited report recommendations are implemented.

23. The safe closure of a landfill is guided by the plans and procedures included in the landfill's "Closure Plan." This plan is typically prepared a few years before closure. Conditions 79 and 80 of the C of A require the preparation of such a plan at least 2 years before site closure, in consultation with the CLC and HRCA. The Panel is satisfied that the landfill can be closed safely with the implementation of these conditions.

24. The Panel has concluded that the East Landfill is a non-hazardous waste landfill much like others in the province. The leachate quality is similar to that of other landfills, the air quality issues are similar to those at other industrial waste landfills, and the nuisance impacts suffered by local residents are no different from those which arise at other landfills. If these circumstances change in the future, careful monitoring will provide the information required to take appropriate action.

25. Over the course of its work, the Panel has come to recognize the vital role which has been played by the CLC in bringing issues of concern with respect to the Taro Landfills into the public eye. While the tone and methods used have sometimes created friction, it is clear that the CLC has accomplished a great deal over the last several years.

    Among other things, the CLC's activities have led to an overhaul of existing legislation pertaining to hazardous wastes, to increased scrutiny of the Taro/Philip operations by the MOE (which in turn has led to changes to their operations), and most recently to the Minister appointing this Expert Panel.

    In its report, the Panel has provided numerous recommendations, which it hopes will allow the CLC to more effectively, fulfill its tasks.

26. The key player in this situation is, of course, the Company (Philip) which operates the East Landfill and is responsible for post-closure care of the West Landfill.

    Waste management is not a business for the faint of heart. It is by its nature a business which raises concerns and often provokes strong and negative reactions from the general public. Nonetheless, the public outcry and concern aroused by the operation of the Taro East Landfill is unusual even for the landfill business.

    Some have suggested that the it was the Company's "aggressive" tactics which led to the current climate of public fear and distrust, others that the well-publicized troubles of the parent corporation have "tarred" the landfill operations. It is also possible that the earlier environmental problems of the West Landfill have affected the public's perception of the state-of-the-art East Landfill facility. The Panel can not rewrite history to change what has transpired in the past. We can and we do encourage all parties to take a new and more positive direction in their mutual relations in the future. More can and must be done by the Company to improve public confidence in its facility. Improvements in site design, operations, and monitoring can help, along with doing everything possible to minimize nuisance issues. The Panel has provided many relevant recommendations which we urge the Company to adopt immediately and voluntarily.

27. The Panel is of the opinion that the MOE is well able to protect public health and the environment at this and other landfills provided that it receives adequate resources (i.e., staff time and funding).

    The recommendations provided in this report should enable the MOE to better carry out these tasks, and the Panel urges the Minister to implement our recommendations and to make available to the MOE the resources necessary for their implementation.

Section 11.0

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List of Appendices

Appendix A: Glossary of Definitions and Acronyms 82

Appendix B: Terms of Reference 91

Appendix C: People with Whom the Panel Met 97

Appendix D: Comments and Recommendations related to the Design and Operations of the East Landfill 100

Appendix E: The Ecosafe Process 103

Appendix F: Analytical Methods 104

Appendix G: MOE Six Point Action Plan 106

Appendix H: Excerpt – Regulation 347 107

Appendix I: Waste Identification Flowchart 110

Appendix J: East Taro Landfill Expert Panel: Responses to Mr. Carmen D'Angelo's Questions 111

Appendix K: Summary of Recommendations 129

Appendix A

Glossary of Definitions and Acronyms

This glossary has been prepared to assist readers of the Panel Report understand some of the technical terms used within the report. In some cases, the definitions have been simplified (from what would be considered scientifically rigorous definitions) in order to make them more understandable.

Activated Sludge Biomass	The biologically active material which is used in the biological treatment system of a wastewater treatment plant.
Aerobic Decomposition	Occurs in moist conditions in the presence of oxygen (produces stronger leachate and little gas).
Ambient Air Quality	The air quality in the area around a facility such as a landfill as affected by all manmade and natural emissions.
Anaerobic Decomposition	The change in physical, chemical and biological composition of materials which occurs in moist conditions in the absence of oxygen. In a landfill this process produces odourous landfill gas and weaker leachate.
Attenuation	Attenuation is a name given to a series of physical, chemical and biological processes which serve to dilute and "filter out" -- and in the case of many organic chemicals, biologically breakdown -- a given chemical as it travels through a medium (in this case, the landfill).
Barrier System	The system of engineered safeguards which together prevent a landfill's leachate from escaping to the environment. Typically includes at least one liner and a leachate collection system to prevent the build up of leachate behind the liner.
Biochemical Oxygen Demand (BOD)	See COD.
Biodegradable	Organic material which can be broken down chemically by biological action.
Biomarkers	Biomarkers are biological indicators or "markers" using human (or at times animal) tissue or fluid to measure either the internal dose of a chemical ("biomarkers of exposure") or the biological response to exposure ("biomarkers of early effect"). Biomarkers of exposure can include measuresof blood, bone or hair for a heavy metal such as lead or mercury and can establish personal exposure for a few contaminants. Biomarkers of early effect can include evidence of chromosomal or molecular changes but cannot

	usually establish links between exposure and effect; nor early effect and future illness. Research is needed to better establish the usefulness of biomarkers in environmental studies of landfills.
Cap	See definition of "cover" material.
Cells	See definition of waste cells."
Certificate of Approval (CofA)	The operating "license" under which a landfill in Ontario operates. The CofA is issued by the Ministry of the Environment (MOE), and usually contains "conditions" which specify how the landfill is to be designed, operated, monitored, and closed.
COD	Chemical oxygen demand (or COD) is a measure, using a strong oxidizing agent, of the amount of oxygen which will be needed to react with the majority of the organic substances in a sample of a liquid such as leachate. By comparison, BOD refers to the amount of oxygen required by micro-organisms in the biochemical oxidation of organic substances in a liquid sample. COD will be high in liquids that are highly contaminated with various substances, while BOD will only be high in liquids that are highly contaminated by readily biodegradable substances.
Containment Wells	Containment Wells are used at landfills where leachate has escaped to the groundwater flow system. The wells are pumped to prevent the leachate from migrating any further. The mix of groundwater and leachate which is pumped from the wells usually requires treatment at a wastewater treatment plant.
Contaminant Migration	The movement of contaminants – commonly used in reference to the movement of contaminants through groundwater.
Contaminating Lifespan	A landfill's "contaminating lifespan" is the amount of time it will take before a landfill's untreated leachate can be released to the environment without causing negative impacts. Typical estimates of contaminating lifespans for landfills are hundreds of years.
Core Sampling	Taking core samples of waste from a landfill using drilling equipment. "Deep core sampling" is taking core samples from deep within a landfill.
Cover Material	Any material used to cover waste in a landfill. There are different classes of cover material, including "final cover" (the cover applied when landfilling has been completed in an area) and "interim cover" (the cover applied when landfilling in an area has finished for the present(i.e for weeks or months) but will resume at some time in the future). The most common cover material is soil.

Critical Contaminant	The contaminant in a landfill which controls the contaminating lifespan of the landfill because it is the last contaminant expected to be reduced to a sufficiently low concentration that the leachate can be released to the environment without a negative impact on the environment. Since it does not easily biodegrade and is very soluble, the most critical contaminant is usually chloride (sodium chloride is common salt).
Dermal Contact	The contact of contaminants with the skin.
Diffusion	A slow, predictable process by which a chemical in a liquid will move from areas of higher to lower concentration. For example, if a few drops of food colour are put in a bucket of water then diffusion will spread the food colour (even in the absence of shaking the bucket or stirring the water) until the colour is evenly spread throughout.
Diffusive Gradient	The difference in concentrations of a dissolved chemical from one area to another divided by the distance between the areas. The higher the diffusive gradient (say across a landfill liner), the faster diffusion will cause chemicals to move through the liner (see alsodefinition of diffusion).
Downgradient	Just as surface water moves downstream in say a creek, groundwater moves downgradient in the groundwater flow system. Areas downgradient of a landfill are those areas towards which groundwater affected by landfill will travel.
Ecosafe	A proprietary process used by Philip to stabilize hazardous waste (see also definitions of stabilization and hazardous waste).
Environmental Assessment (EA)	A comprehensive assessment of the potential impacts of a proposed undertaking (e.g. a new landfill) on the environment.
Epidemiology	The study of patterns of disease and health in populations, and their variation over time and from one location to another.
Fugitive Dust Emissions	Dust which has "escaped" from a site due to materials handling, traffic and wind erosion. These emissions can arise from landfilling and quarrying operations, as well as traffic on both paved and unpaved roads.
Full Scan	A broad test for organic chemicals which will detect any organic chemical present, as compared to a "target" scan which will only detect certain chemicals which are being targeted by the scan. Full scans are also sometimes referred to as "open" scans.
Gas Chromatography – Mass Spectrometry Analysis	An analytical process that uses gas chromatography to separate the chemical components of a air or water sample. These separated components are then analysed using a technique call mass spectrometry, which allows the

	identification of the chemicals.
Geomembrane Liner	A liner made of sturdy synthetic materials (for example a plastic like high density polyethylene). See also the definition of liner.
Gradient	The difference in levels of a parameter over a given distance Note that the bigger the difference, the higher the gradient (see also definitions of hydraulic gradient and diffusive gradient).
Groundwater	Water which is found below the ground surface. It is visible only when it discharges from the ground in the form of seeps or springs, or when it seeps into holes which have been dug below the water table.
Hazardous Wastes	Those wastes which a given jurisdiction (e.g. the Province of Ontario) has defined as being "hazardous." The definition of hazardous waste often differs from one country, province or state to another. In Ontario, "hazardous wastes" are those wastes which meet the definition of hazardous waste set out in Ontario Regulation 347 (Appendix H).
Health Outcomes	Health outcomes include all of the possible health states that can occur. To individuals including the explicit states of ill health such as disease, injury, disability and death as well as "softer" conditions such as distress, minor symptoms (headache, fatigue) and concern. There are few situations where a specific exposure is the only cause of an outcome. Causes of diseases such as cancer are multi-factorial and not completely understood. "Excess" health outcomes occur when a group with exposure is compared with a very similar group without exposure and the exposed group has more of the health problem of interest than the unexposed group.
Heavy Metals	Usually refers to metals like lead, zinc, cadmium, and copper which can cause problems if they are present in drinking water and/or in surface waters or in air.
Hydraulic Conductivity	A measure of the permeability of a porous medium (e.g. soil, bedrock, waste, etc.). A highly permeable material allows water to pass through the material very quickly.
Hydraulic Containment	A method of containing a landfill's leachate "hydraulically" by pumping groundwater or leachate in order to influence the direction of groundwater or leachate movement in the vicinity of the landfill (see also definition of hydraulic trap).
Hydraulic Control Layer	A layer in a barrier system which is used to hydraulically contain the leachate in a landfill (see also definition of barrier system).
Hydraulic Gradient	The difference in levels of groundwater pressure (or

	hydraulic head) from one area to another divided by the distance between the areas. The higher the hydraulic gradient (e.g. across a landfill liner), the faster groundwater or leachate will be able to move through the liner (see also definition of gradient).
Hydraulic Trap	A method of hydraulically containing a landfill's leachate, by keeping leachate levels within the landfill lower than groundwater levels around the landfill. This ensures that any groundwater movement through the landfill's barrier system will be inward (into the landfill) rather than outward (see also definition of hydraulic containment).
Hydrogeology	The study of how groundwater and substances in the groundwater move from one place to another below the ground surface.
Indicator Parameter	A parameter used as an indicator of the presence of landfill leachate.
Landfill	A place where wastes are disposed of in an organized fashion. Usually includes an initial excavation which is filled with waste and often also includes waste mounded up above the ground surface. When closed, a landfill is covered with a layer of soil and topsoil, and is then vegetated.
Landfill Gas	As wastes in the landfill decompose (under anaerobic conditions) they produce gas - usually a mixture of methane and carbon dioxide (both of which are odourless), and <1% trace gases (e.g. "rotten egg gas") which can have strong and often unpleasant odours even in very low concentrations (the nose is a very sensitive detector). These are usually produced early on in the life of the landfill.
Leach Test	A test in which water (often acidified to a specific level) is passed through a sample of waste for a specified period of time in order to determine which contaminants may potentially leach out of the waste.
Leachate Toxicity Test	A type of leach test which is used in Ontario to determine if a given waste is "leachate toxic" – note that by definition, in Ontario leachate toxic wastes are hazardous wastes.
Leachate	The contaminated liquid which builds up in a landfill site. Leachate is generated when rain or other water comes into contact with the wastes in a landfill, and it contains chemicals which have "leached" out of the landfill including dissolved solids and products of decomposition of organic matter. Though leachate contains many contaminants, **it is usually not a "hazardous waste"** (see also definition of hazardous waste).
Leachate Collection	The engineered system which is used to collect the leachate

System	from a landfill, which typically includes drainage pipes and pumps.
Liner	A relatively impermeable material (either a clay-type soil or a synthetic material) which is placed below and along the sides of a landfill, in order to control the leakage of leachate from the landfill to negligible, or at least acceptable, levels.
MAC	Maximum Acceptable Concentration of a health-related parameter in drinking water as set out in the Ontario Drinking Water Objectives.
Mass Loading	The mass of a substance which is being discharged to a surface water over a given period of time. For example, assume Landfill One is discharging chloride at a concentration of 1000 milligrams per Liter (mg/L) whereas Landfill Two is discharging 500 mg/L chloride. If the average flow from Landfill One is 10,000 Liters per day (L/day) and from Landfill Two is 100,000 L/day, then the mass loading from the two landfills will be 10 kilograms vs. 50 kilograms per day respectively.
MOE	The Ontario Ministry of the Environment.
Municipal Solid Waste (MSW)	Wastes collected by or for municipalities, including household wastes and similar wastes from commercial activities, office buildings, institutions. May include waste from industries which dispose of their waste at municipal facilities. They may includes small quantities of material that, in larger quantities, would be classified as hazardous wastes. Municipal Solid Waste is considered non-hazardous in the Regulation
Non-hazardous Wastes	Those wastes which a given jurisdiction (e.g. the Province of Ontario) has defined as being "non-hazardous." The definition of non-hazardous waste often differs from one country, state or province to another. In Ontario, "non-hazardous wastes" are those wastes which meet the definition of non-hazardous waste set out in Ontario Regulation 347.
Ontario Drinking Water Objectives	Also known as the "ODWO," these are the water quality standards which water used for human consumption in Ontario should meet. They have been developed and are periodically updated by the Ministry of the Environment.
Open Scan	A broad test for organic chemicals which will detect any organic chemical present, as compared to a "target" scan which will only detect certain chemicals which are being targeted by the scan. Open scans are also sometimes referred to as full scans.
Overstrength Agreement	An agreement between a municipality and a major wastewater discharger, which allows wastewater

	discharges to the sewer system which exceed the concentration limits set out in the municipality's Sewer Use By-Law. Such overstrength discharges are usually subjected to a surcharge, under which the discharger pays extra for permission to make the overstrength discharge.
Paradigm	A way of looking at a system, based on set of assumptions about how that system works.
Particulates	The fine solid materials which are present in air. Includes soil particles, as well as particles produced by other processes (e.g. fires, combustion in motor vehicles, etc.).
Phytotoxicity	The degree to which a particular substance (e.g. leachate) is toxic to plants.
PM10 or PM 2.5	The amount of particles in the air which are less than 10 microns or 2.5 microns respectively in size. Note that a micron is one millionth of a meter in length (i.e.,, one thousandth of a millimeter). The presence of these very small particles is of more concern than total dust levels, since these particles can be inhaled into the lungs. Larger particles are typically trapped in either the mouth or nose and do not get into the human lung.
Pre-treatment	The use of one or more treatment methods to reduce the levels one or more parameters in a wastewater, prior to that wastewater being discharged (to a sanitary sewer or a wastewater treatment plant).
Provincial Water Quality Objectives	Also known as the "PWQO," these are the water quality standards which apply to surface waters in Ontario. They have been developed and are periodically updated by the Ministry of the Environment.
Psychosocial Effects	Psychosocial effects are defined as the complex of distress, dysfunction and disability, manifested in a wide range of psychological, social and behavioral outcomes in individuals, groups and communities as a consequence of actual and/or perceived environmental contamination. An increased prevalence of self-reported symptoms such as fatigue, sleepiness, and headaches among residents near landfills has been reported - it is difficult to conclude whether these symptoms are an effect of direct toxicological action of chemicals present in landfills, an effect of stress and fears and nuisances related to the landfill, or an effect of reporting bias.
Reasonable Use Policy	A policy developed by the Ontario Ministry of the Environment which stipulates that the "reasonable use" of groundwater on properties adjacent to landfills must be assured by the landfill operator, through measures which keep leachate impacts on groundwater to an acceptable minimum.

Respiratory Irritation	Irritation of the respiratory system (i.e.,, the mouth, nose, throat, lungs).
Respirometry	The use of microorganisms to measure how fast and how well a waste is capable of being degraded biologically. It is used as an indicator of the ability of a biological wastewater treatment plant's capability to successfully handle a specific wastewater.
Reverse Osmosis or RO	A physical water treatment process which involves the removal of dissolved salts and other compounds, including organics, through a semi-permeable membrane using a pressure greater than the osmotic pressure caused by the dissolved salts. It is a relatively sophisticated treatment process. The compounds removed by this process usually must be treated as hazardous waste.
Service Area	The geographical area from which a landfill is licensed to receive waste.
Sewer Use By-Law	A By-Law which regulates which liquids may be discharged to a sewer system, and which sets out the permissible concentrations of various parameters in the liquids being discharged. The By-Law may be superseded by individual agreements between the municipality and major wastewater dischargers (see also definition of overstrength agreements).
Split Sampling	Taking several sets of samples, to be analyzed separately, in order to verify the validity of sampling and testing procedures and results.
Stabilization	The use of physical, chemical or biological processes to transform a hazardous waste so that it meets the definition of and therefore becomes non-hazardous waste.
Storm Water	Surface water running off a landfill (e.g. during a rainstorm) is often referred to as storm water.
Storm Water Management Plan	A plan that describes how stormwater runoff from a landfill will be dealt with.
Surface Water	Water which is ponded or flowing above the ground surface. This includes water in ponds, creeks and wetlands. Surface water running off a landfill (e.g. during a rainstorm) is often referred to as storm water.
TAGA Unit	The mobile air quality sampling unit of the Ministry of the Environment.
Total Suspended Particles (TSP)	(see also PM10 and PM2.5) Total suspended particulates are all small dust particles that are less the 44 microns (A micron is one millionth of a meter in length). These are typically collected by a high volume sampler that collects the particulate on a filter. TSP standards have been based on visibility effects. A TSP sampler also collects the finer

	PM10 and PM2.5 particulates.
Toxic Substances	Substances which are toxic (i.e.,, poisonous).
Toxicology	The science that deals with the origins, nature, and health impacts of poisons.
VOCs	Volatile organic chemicals, that is organic chemicals which will rapidly volatilize (i.e.,, evaporate) when exposed to air. Benzene (a component of gasoline) is an example of a VOC. VOCs may can cause health impacts if ingested or inhaled, and therefore often have low permissible levels in drinking water and in air.
Waste Cells	A landfill is usually divided into a number of "cells" or areas which are landfilled one at a time. By landfilling in a smaller, defined area (a cell) the area of exposed wastes is reduced and nuisance impacts are minimized.
Waste Stream	The wastes coming to a landfill from a specific source.
Wastewater Treatment Plant (or WWTP)	A facility used to treat "wastewater" (usually consisting of a mix of sewage, stormwater, and industrial process discharges). Landfill leachate is almost always treated at WWTPs.
Working Area or Working Face	That part of the landfill where active waste disposal is currently taking place.

Appendix B
Terms of Reference

Terms of Reference
for the
Taro East Landfill Expert Panel

Introduction

On September 17, 1999 the Ministry released the results of an investigation into the shipment of waste from CyanoKEM in Michigan by Philip Enterprises Inc. as well as preliminary results of a district office audit of the company's waste processing facilities in Hamilton.

The investigation and audit, while not leading to charges against Philip Enterprises, found a number of deficiencies with the existing hazardous waste regulation and approvals for waste facilities.

To address these deficiencies Environment Minister Tony Clement announced a six-point action plan (attached). Among other actions the plan calls for the establishment of an independent expert panel to examine the potential for any long-term effects as a result of waste deposited at the Taro East Landfill. The Ministry has consulted with the Stoney Creek community, through the Community Liaison Committee (CLC), to provide recommendations for the composition and terms of reference of such an expert panel.

Background

Philip Service Corp. (PSC) operate a number of waste transfer /processing sites and a solid non-hazardous waste landfill in the Hamilton area. The landfill property in upper Stoney Creek has been operated as a limestone quarry under licence from the Ministry of Natural Resources since 1950.

The Taro properties were purchased by Philip in 1990, consisting of the East Quarry limestone quarry operations and the operating West Quarry Landfill. Philip operated the West Quarry Landfill from 1990 to 1995. The East Quarry is still being mined.

PSC planned to rehabilitate the quarried out area by seeking approval from the Ministry of the Environment for a landfill site for non-hazardous waste. The company undertook public consultation and preparation of technical reports following prescribed protocols that lead to submission of an Environmental Assessment of the proposed landfill. In July 1996, the Minister of the day announced the decision to accept the environmental assessment. The undertaking was subsequently issued a Certificate of Approval under

Part V of the Environmental Protection Act in September 1996. The site began to receive waste in December 1996.

In September 1998 the Ministry received allegations that the landfill had been receiving processed hazardous waste (hazardous industrial waste) for disposal and the ministry launched an investigation. As a result of the investigation, the ministry has concluded that, given the circumstances and wording of the relevant portions of Regulation 347, the waste handling procedures in question were not in violation of Regulation 347. The interpretation of the mixing rule, held by the ministry's Waste Management Policy Branch, which implies that hazardous industrial waste (schedule 1 listed waste) when mixed with any other waste or material remains a schedule 1 waste is not supported by legislation. This policy would require a rigorous de-listing process or site specific approval to allow a listed hazardous waste to be rendered and treated as non-hazardous.

On September 17, 1999 the Minister announced the "Six Point Action Plan" to strengthen Ontario's hazardous waste regulations and the requirements for hazardous waste facilities. The plan included the establishment of an independent expert panel to examine the potential for any long-term effects as a result of the deposition of waste in the Taro East Landfill.

MANDATE

The ministry is seeking expert opinion from the panel on the potential for any long-term adverse affects relating to waste disposal practices at the Taro East Landfill and recommendations with respect to monitoring practices and safeguards currently implemented at the landfill, including:

- Potential long-term health impacts to the community related to waste disposal at the landfill

- Potential long-term environmental impacts related to waste disposal at the landfill

- Adequacy of existing measures to monitor, mitigate, prevent, reduce or otherwise control or assess impacts from the landfill on, human health, air quality, ground water and surface water.

The Ministry expects the panel to review the available information regarding past and current practices at the landfill including a review of the following information:

- existing documents relating to the design and operation of the landfill,
- company's design and operation manual,
- the company's annual report summaries, including annual monitoring results,
- Ministry and company analytical results relating to waste characterization, landfill leachate characterization, ground and surface water quality and air quality data, and
- the investigators' reports into the CyanoKem waste processing and disposal.

The Ministry anticipates that 8 to10 meetings scheduled at two week intervals would be appropriate to review information and discuss issues and prepare recommendations.

The Ministry recommends a workshop approach to the tasks, where information is reviewed and recommendations made as a group. This approach will result in the Minister benefitting from the collective wisdom of the panel and will assist the panel in focusing on the tasks at hand.

It is anticipated that an initial meeting would facilitate introductions, the establishment of ground rules, and the identification of action items and effort to be applied to project tasks, and a schedule for completion of the work.

In addition to any presentations of draft material, the panel will also complete a final report with findings and recommendations. The release of this report will also include a presentation to the CLC at a meeting to be held as soon as possible after the submission of the report to the Minister. Comments will be solicited from the CLC and the public at this meeting, and submitted as an addendum to the final document.

SCOPE

Documentation will be provided to the committee for their review including the following:

EA Approval
EPA Approval
Design and Operations Manual for landfill
Investigations and Enforcement Branch Investigation Reports
District Audit Report
Sampling results - air, surface and ground water, leachate
Landfill Annual Reports
Health Studies and related reports
Waste sampling and analytical information

TERM

It is proposed that the Committee will be established shortly after the Minister's announcement of the membership. Workplans and schedules will be developed. The Ministry is estimating that the entire project will take five to six months to complete involving a time commitment of 20 to 30 days for each member.

MEMBERSHIP

Public allegations of improper hazardous waste disposal and ministry findings regarding deficiencies with the hazardous waste legislation has generated significant public outrage and lack of confidence in the government's ability to protect the environment and public health.

An independent public expert panel is needed to advise the Minister and help rebuild public trust and confidence. Activities undertaken to date by both the Ministry and the company have not satisfied public concerns. An independent body of experts, represented by academia and the consulting industry will provide a much needed independent service to advise the Minister and the public with respect to the adequacy of controls and monitoring at the site and any other measures necessary or advisable to restore public confidence and protect human health and the natural environment.

The proposed panel members represent a combination of individuals proposed by either the Taro Community Liaison Committee, or recognized by the ministry as experts in their discipline. The proposed candidates were selected on the basis of conflict of interest principles, availability for the assignment, background and credentials, and credibility. In some cases there was not a large number of local people who would be viewed as independent and expert in their field.

As well, a variety of expertise is needed to deal with the complex, multi-media impacts of landfill contaminants. These contaminants may have the potential move off site through a number of pathways including; landfill leachate, surface runoff, ground water contamination, volatilization and wind blown particulate.

With these criteria in mind, the panel will comprise representatives from the following disciplines:

- Project Facilitator to manage and co-ordinate the review carried out by the expert panel, as well as to act as liaison with MOE and CLC. This individual will also be responsible for the two progress reports and the presentation of the final report.
- Human Health Impact Experts / toxicologist
- Hydrogeologist / contaminant transport
- Organic chemist / fate of organics in the environment
- Landfill Design and Operation Expert and Waste Processing Expert
- Water Treatment Expert
- Air Quality Expert

Members shall not be current or past employees of PSC. Members shall not have supplied services to PSC unless such services were provided through a competitive public tender process. Members and their employers or affiliations shall not have any personal gain arising from their findings or recommendations other than appropriate remuneration for serving on the committee.

SCHEDULE

Announce Members of Committee	March 2000
First Progress Report to CLC at Monthly Meeting	to be determined, 2000

Second Progress Report to CLC at Monthly Meeting	to be determined, 2000
Submit Report to Minister	July, 2000
Presentation to CLC	August, 2000
Addendum Report to Minister	August,2000

ADMINISTRATIVE ARRANGEMENTS

Accountability

The Facilitator is accountable to the Minister for the performance of the Committee in fulfilling its mandate and for carrying out the roles and responsibilities assigned to the Facilitator by Management Board Directives and these Terms of Reference.

The Facilitator will, at the request of the Minister or the Deputy Minister, supply, in a timely fashion, specific data and other information which may be required from time to time for the purposes of Ministry administration.

Committee members are accountable for operating in accordance with all administrative policies established and specified in Management Board of Cabinet Directives and Guidelines and the Ministry's corporate financial and administrative policies and procedures manual.

Committe members are accountable for ensuring that public funds are used with integrity and honesty and within the approved funding in the fulfilment of their mandate and in accordance with Schedule A;

Responsibilities

The Facilitator is responsible for:

- ensuring that the Committee carries out the responsibilities assigned to it in the Terms of Reference;
- recommending all formal documents related to the fulfilment of the Committee's mandate, and submitting them to the Minister for review for the purposes of approval;
- making presentations and speaking on behalf of the Taro Landfill Review committee;

- operating the Committee so as to ensure compliance with Management Board Directives and Guidelines and the Corporate Financial and Administrative Policies and Procedures Manual of the Ministry.

Committee members are responsible for:

- providing their expert, unbiased opinion to carry out the mandate of the Committee as provided in these Terms of Reference.

Mar 2, 2000

Appendix C

People with Whom the Panel Met

The following People met with members of the Panel between the months of April and October, 2000:

April		
	MOE officials :	Kal Hannif (April 10) John Percy (April 10) Carl Slater (April 10)
	Taro Staff:	Wayne Jackman (April 14 – the site visit) Derek McLurg (April14)
May		
	MOE Staff	Carl Slater (May 8) John Percy (May 8) Mark Dunn (May 8) & Others including: Terry O'Neill, Marcia Smith, Brad Farnand, Steven Radcliffe
	CLC members:	Carmen D'Angelo (May 17) Dave Barlow (May 17)
	Taro/Philip Staff:	Wayne Jackman (may 8, May 31) Mike Jovanovic (May 8, May 31) Doug Hodgson (Corporate counsel) (May 8, May 31)
	Politicians:	Mayor Anne Bain (May 17)
	Journalists:	Richard Leitner (May 17)
	Consultants:	Colin Isaacs (May 31) Colin Baynes (May 16) Doug Bryant (May 16) Mark Nazar (May 31) Several Taro/Philip Consultants including: Stan Feenstra, Steve Usher and Heather Malcolmson
June		

Governmental Agencies:
Dale Millar (June 13) – City of Hamilton/Wentworth
Mark Jeffries (June 13) – City of Hamilton/Wentworth
Tony Horvat (June 27) – HRCA
Andy Dominski (June 27) - EAAB staff
Bill Hunter (June 14) – MoH
Frank Dobroff (June 14) – MOE

Consultants:
Bob Willes (June 27) – CanTox
Heather Malcolmson (June 22) Gartner Lee Ltd.

General Public Meeting: June 28
(**at** which time the Panel met with a number of residents of Stoney Creek and other interested parties)

July

Politicians:
MPP Brad Clark (July 4th; July 18)
Doug Conley (July 4th)

MOE staff:
Ingrid Thompson (July 26)
Kal Hannif (July 26)
John Percy (July 26)
& Minister's Office Personnel

Journalists:
Paul Palango (July 18)

Consultants:
Dr. Rosalie Bertell (July 4)
Roger Dixon (July 4)

Philip/Taro:
Doug Hodgson (July 18)
Wayne Jackman (July 18)
Imperial Street Staff (July 18)

Other:
Jamie Yacoumidis (July 17) – C.I.E.L.P

August

City Staff:	Steve Miazga (August 29) Stoney Creek, Planning Dept.
Politicians:	MPP Brad Clark (August 29)
CLC:	Carmen D'Angelo (August 29)
Others:	Dr. Mike Jerrett (August 29) – McMaster University Dr. M. Sears (August 29) – ISAAC project
Taro/Philip:	Staff (August 22)

September

MOE staff:	Minister Dan Newman (sept. 13) Deputy Minister Ingrid Thompson John Percy Kal Hannif & other members of the Minister's Staff
Others:	Dr. Sorger (Sept. 22) – McMaster University George Watson (Sept. 22) Mr. Eleveld (Sept. 22)

Appendix D

Comments and Recommendations related to the Design and Operations of the East Landfill

D1: Recommendations

The Panel provides the following detailed comments and recommendations regarding the design and operation of the East Landfill.

1. The "Maintenance and Operations Manual[1]" indicates that water will be introduced to the hydraulic control layer (HCL) but does not clearly define how this will be done. ***It is recommended that the issue of how and where the water will be introduced be addressed in more detail with particular attention to minimizing the aeration of the water during its introduction and expelling air from the system during saturation.***

2. The proposed design and operation involves all leachate draining from a 59 ha landfill to a single leachate pumping station.[2] Thus to the extent that the system is likely to experience problems due to clogging, these are most likely to occur in the vicinity of the pumping station where the mass loading is concentrated. Since this part of the system has not yet gone to final design or construction, and given the 300 year contaminating lifespan predicted by Taro's consultants, ***it is recommended that Taro's consultants consider installing one, or even two, back-up (redundant) pumping stations at some distance from the proposed pumping station. These could be used to control the leachate head in the event that, in the long term, there was clogging around the existing pumping station.***

3. The proposed design involves maintaining Pumping Well M4 passing through the waste. While there are certainly advantages to having a contingency pumping well, it would be far better to have the contingency well located outside the footprint of the landfill. This is because the proposed design[3] may not prevent leakage of contaminants from the waste to the groundwater for the 300 year contaminating lifespan of the landfill. This "penetration" through an otherwise well designed barrier system represent the "weakest link" and it is strongly recommended that this design feature be re-evaluated. Since this part of the system has not yet gone to final design or construction, and given the 300 year contaminating lifespan predicted by Taro's consultants, ***it is recommended that Taro's consultants consider sealing Pumping Well M4 like the others within the footprint and if a contingency well is needed, consider constructing one outside the landfill foot print.***

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[1] Taro East Quarry Landfill, Maintenance and Operations Manual, Gartner Lee Ltd , Draft December 1996, pp. 6-7.

[2] Taro East Quarry Landfill Maintenance and Operations Manual, Gartner Lee Ltd , Draft December 1996, Fig. 10.

[3] Taro East Quarry Environmental Assessment, Design and Operations Report, Gartner Lee Ltd., January 1995, p. 101 & Fig. 22.

4. It is understood that Phase 1B has not been constructed (to allow completion of Phase 1 and installation of the cover as proposed in the original design and operations report[4]) due to the need to resolve an easement issue. ***It is recommended that Phase 1B be completed and the final cover placed in this area as soon as practicable in an effort to minimize dust from the landfill and to improve its appearance.***

5. The design adopted for the geomembrane is consistent with the state-of-knowledge at the time of landfill approval and with the design life of 20 years. However there is the potential to get a substantially longer design life and, although not strictly essential, it would seem prudent to do so given the long contaminating lifespan and the greater than anticipated significance of chloride and sodium. In this regard ***it is recommended that (a) testing be conducted to ensure that the geomembrane meets the requirements of Ont. Reg. 232/98, Schedule 3, Clause 1.2 and 1.3 (there is a reasonable probability that the geomembrane material that has been used does meet this requirement but it would be useful to confirm this in future); and (b) a more robust protection layer be used above the geomembrane.***

6. As noted in the following section, in future ***it is recommended that the lift thickness be reduced to 150mm in association with the use of the CAT815 compactor for all but the first liner lift (which should be thicker than 200mm to protect the underlying geotextile) to minimize potential problems and further enhance public confidence in the liner.***

7. ***It is recommended that the data on leachate levels in the leachate collection system and water levels in the hydraulic control layer (HCL) be more clearly reported in a single table for all monitors in the East Landfill. Also the chemistry in the HCL should be monitored and clearly reported.***

D2: Barrier System Construction – Review and Comments

a) The construction of the liner has been the subject of extensive monitoring and quality control checking as documented for Phase 1A (1996)[5] and (1997),[6] Phase 2 (1997),[7] and Phase 3A (1999).[8] Quality control tests conducted for the compacted clay liners indicate that the water content and density were such that a high quality liner can be expected. The hydraulic conductivity tests indicate that the construction specification of a hydraulic conductivity of less than $5x10^{-10}$ m/s was met and the laboratory suggest that after the waste is placed, the hydraulic conductivity of the liner is likely to be about five (5) times better than specified with a hydraulic conductivity of about 1.1×10^{-10} m/s. Some deficiencies were detected during construction and the documentation indicates that these were fixed. It would appear that at least part of the reason for these problems[9] was the fact that the liner was compacted in 200mm thick compacted layers (or "lifts" as they are commonly known) with a CAT815 (having feet 198mm long) which could not penetrate through the entire lift thickness in areas where there had been truck traffic. Although reasonable steps appear to have been taken to identify and address the problems where detected, in future it would seem prudent to adopt a more common 150mm lift thickness in association with the use of a CAT815 for all but the first liner lift (which should be thicker than 200mm to protect the underlying geotextile if the CAT815 is used on the first lift – a compacted thickness of 250mm is recommended for the first "lift" followed by five (5) 150mm thick compacted lifts to give a 1m thick liner) to minimising future problems and enhancing public confidence in the liner.

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[4] Taro East Quarry Environmental Assessment, Design and Operations Report, Gartner Lee Ltd., January 1995, Fig. 15.

[5] Taro East Landfill 1996 Phase 1A Base Liner and Leachate Collection System Construction Inspection Report, Gartner Lee Ltd., December 1996.

[6] Taro East Landfill 1997 Phase 1A Base Liner and Leachate Collection System Construction Inspection Report, Gartner Lee Ltd., November 1997.

[7] Taro East Landfill Phase 2 Base Liner and Leachate Collection System Construction Inspection Report, Gartner Lee Ltd., March 1998

[8] Taro East Landfill Phase 3A Base Liner and Leachate Collection System Construction Inspection Report, Gartner Lee Ltd., June 2000.

b) The information provided regarding liner quality control has the potential to be confusing and could be misinterpreted. For example, an inspection of the Phase 3A water content control data indicates that for the secondary liner only about 60% of field compaction data is said to meet the specification (with the other 40% being either marginal or not passing) and on some days the success rate was very low. Often the points not passing prompted corrective action (a change in water content or more compaction) and a subsequent test in the same area "passed" the requirements. However this is not immediately obvious and it is recommended that in future it be clearly indicated when a test is a "re-test' of a failed or marginal area and that the area did meet the specification before it was accepted. This will minimise the potential for misunderstanding or misinterpretation of the data. It is noted that the hydraulic conductivity data does indicate that a low hydraulic conductivity was achieved (the mean of laboratory data is about 1×10^{-10} m/s) which more than meets the specification of less than 5×10^{-10} m/s.

In summary, the independent data provided by the consultants responsible for checking liner construction provide confidence that the liner has been constructed in accordance with typical design specifications and, in terms of the laboratory hydraulic conductivity data, may in fact be considerably better than specified.

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[9] Taro East Landfill 1997 Phase 1A Base Liner and Leachate Collection System Construction Inspection Report, Gartner Lee Ltd., November 1997, pp. 12-13.

Appendix E
The Ecosafe Process

There are a number of patented processes which can reduce the solubility of heavy metal ions, mainly by converting them into water-insoluble silicates and other derivatives. Some claim that the metals and even some organic compounds are being built into intricate silicate structures which encapsulate ions and molecules. To stabilize leachate-toxic wastes, the Company uses one of these processes which it calls the **Ecosafe** process (Currently, 54 facilities in the United States are using either the EcoSafe process or a derivation thereof. No comparable figures could be found for Ontario).

The Expert Panel toured the Imperial Street facility to learn more about the Ecosafe process; and also reviewed a document entitled "Technical Review of the Ecosafe Process" prepared for the Company by a consultant, as required in the revised CofA for Imperial St.

Stabilization of leachate toxic wastes is achieved by converting water soluble metal compounds into hydroxides, sulphides, sulphates, carbonates and phosphates. The solubilities of these derivatives vary from metal to metal and the key to successful treatment is the optimization of the additive mixture for a given waste.

Portland cement based stabilizations involve metal silicate formation in addition to that of hydroxides and carbonates. Oxidizing or reducing agents are used to convert certain contaminant elements into their higher or lower stage of oxidation to facilitate their stabilization. In other words, there is a sound chemical basis for making leachate toxic hazardous wastes non-toxic.

Notwithstanding the above comments, the Panel is aware that at least one MOE reviewer has had concerns about the ability of the EcoSafe process to stabilize wastes.[10] However, based on the data in the consultant's report (which is currently being reviewed by the MOE), and the input of the Panel's own expert on chemistry, the Panel concluded that the Ecosafe process is an effective and very useful technology for the treatment of leachate toxic wastes. The Panel did however have some concerns about the unproven homogeneity of the final product and the efficacy of the current mixing technique used. Little attention was paid to the mixing issues in the Taro report.

The Panel recommends that the Company and the MOE further assess the suitability of the current mixing procedures (which involve the use of a front-end loader) as part of the review of the EcoSafe process.

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[10] Memorandum to Mark Dunn from Gilles Castonguay (Senior Engineeer, Hazardous Wastes, Technology Standards Section, MOE) date September 21, 2000 and entitled, "Process Variability: Ecosafe process, Philip Services Corp."

Appendix F
Analytical Methods

The MISA groups analyses specified in the Certificate of Approval for Taro East landfill leachates are all target analyses. The instrument used is a gas chromatograph with an ion specific detector.

The latter is a small bench-top mass spectrometer. The scan is calibrated with a set of pure standards for quantitation and for retention times. The retention time is the time it takes for the peak representing an organic compound to appear in the chromatogram from start=0.00 min. The mass spectrometer identifies the eluting organic compound using three ions from the mass spectrum, characteristic to that compound. The retention time has to be correct and the three specified ions have to be present before the compound is accepted as listed. Only listed compounds appear in the analytical report. Unspecified compounds can not be quantified but they do appear in the recorded chromatogram. The analyst can attempt to identify them by using the mass spectrometer's library. The libraries of these small mass spectrometers are limited. Usually, these analyses are highly automated and the system can be left to run unattended. These target analyses are very useful with contaminants with specified maximum allowable concentrations at low levels. There are 8 Misa groups specified in the CofA for leachate analysis representing 125 fairly common and significant parameters:

MISA Group #	Type of organic compounds	Number of parameters
16	Volatile Organics	26
17	Non-halogenated Volatiles	6
18	Water Soluble Volatiles	2
19	Base-neutral Extractables	39
20	Acid Extractables	19
21	Phenoxy acid Herbicides	3
22	Organochlorine Compounds	24
23	Neutral Chlorinated Compounds	

According to the East Landfill leachate analyses in the 1998 Taro East annual report, the leachates are unusually low in specific organic contaminants other than some phenols at the ug/L levels, while the chemical oxygen demand is fairly high and the Total Organic Carbon (TOC) is high at the mg/L level. This raises the question of whether any unspecified non-target but significant contaminants appeared in the chromatograms during analysis. This is where Open Scan Mass Spectrometry would be helpful. This technique is excellent for identification and gives semi-quantitative results. Once an unknown compound is identified the measurement can be made more precise by retroactive standardization with an external standard.

The reported analytical results account for only a portion of the total organic carbon or the total dissolved carbon in the leachate. This large difference may be due to the presence of highly water soluble organic compounds, such as glycols, carbohydrates and humic substances not normally measured in leachate analysis. It should be noted that these substances are relatively benign and as such are not measured. Also there is also hydrocarbon contaminated soil in the landfill that can account for some of the high total organic carbon in the leachate. Nevertheless, it would be useful to characterize these organic compounds.

The MOE mass spectrometric laboratory has developed a liquid chromatography-mass spectrometric system which can characterize or identify highly water soluble or thermally unstable organic compounds which can not be extracted or analysed by gas chromatography. Such an analytical study would be an excellent **alternative to landfill sampling**. Landfill sampling can be considered to be similar to a medical biopsy carried out in the dark. With respect to the protection of human health, it is far more important to know what is coming out of the landfill site than what is in the landfill. If one thinks about it, even one hundred core samples represent only a minuscule fraction of the landfill's volume. Leachate and emitted gas samples represent the whole landfill and their analysis will indicate any hazard the landfill may pose to the citizens of Stoney Creek. As part of this study, we would recommend that MOE also undertake a number of samples at other landfills (some non-hazardous industrial and some municipal solid waste) for comparative purposes.

The Panel recommends that the Ministry of the Environment undertake a limited mass spectrometric study of the leachate from the Taro landfill and from 3 other industrial waste facilities for comparison. Leachate samples and emitted gas samples (cartridge) should be analysed by open scan mass spectrometry at high sensitivity.

Appendix G
MOE Six Point Action Plan

The plan involves:

1. Giving immediate legal force to the Generator Registration Manual. This policy manual, in use since 1985, outlines how different types of hazardous waste are described.
2. Revising the hazardous waste regulation, effective immediately, to ensure that, even if a hazardous waste is mixed with other substances, it will still be considered the same type of hazardous waste. This old flawed regulation has been in effect since 1985.
3. Revising the current hazardous waste manifesting and regulation, to be the toughest in Ontario history, with a view to strengthening and modernizing it to become comparable to, and compatible with, U.S. rules.
4. Amending the Certificate of Approval for the Philip Enterprises' Imperial Street facility in Hamilton. This will tighten the Certificate of Approval, and impose more stringent restrictions on waste stabilization and disposal.
5. Revising other Certificates of Approval of a similar nature that have been issued at other sites across Ontario.
6. Immediately establishing an independent expert panel to examine the potential for any long-term effects as a result of waste deposited at the Taro East landfill. The ministry will consult on this proposal with the Stoney Creek community, through the Community Liaison Committee, to determine the composition and terms of reference of such an expert panel.

In addition, the minister has called upon the federal environment minister to provide to the Ontario Ministry of the Environment all relevant information on all future hazardous waste imports so that we can ensure that such waste will be appropriately handled in Ontario. This will provide Ontario with the information it will need to decide if it agrees with such importations.

Appendix H
Excerpt – Regulation 347

This is excerpted text from: General -- Waste Management

R.R.O. 1990, Reg. 347

As amended by: O. Reg. 183/92; 240/92; 501/92; 555/92; 457/93; 507/93; 105/94; 190/94; 298/94; 299/94; 512/95; 128/98; 157/98; 191/98; 460/99

Section 1 DEFINITIONS

acute hazardous waste chemical" means,

(a) a commercial waste chemical having a generic name listed in Part A of Schedule 2, other than a waste described in Schedule 2.1, or
(b) a mixture of a waste referred to in clause (a) and any other waste or material…generator" means the operator of a waste generation facility;

"hazardous industrial waste" means,

(a) a generic or specific waste listed in Schedule 1, other than a waste described in Schedule 1.1, or
(b) a mixture of a waste referred to in clause (a) and any other waste or material;

"hazardous waste" means a waste that is a,

(a) hazardous industrial waste,
(b) acute hazardous waste chemical,
(c) hazardous waste chemical,
(d) severely toxic waste,
(e) ignitable waste,
(f) corrosive waste,
(g) reactive waste,
(h) radioactive waste, except radioisotope wastes disposed of in a landfilling site in accordance with the written instructions of the Canadian Nuclear Safety Commission or the Atomic Energy Control Board,
(i) pathological waste,
(j) leachate toxic waste, or
(k) PCB waste as defined in Regulation 362 of the Revised Regulations of Ontario, 1990, but does not include,
(l) hauled sewage,
(m) waste from the operation of a sewage works subject to the Ontario Water Resources Act where the works,
    (i) is owned by a municipality, I

(ii) is owned by the Crown subject to an agreement with a municipality under the Ontario Water Resources Act, or

(iii) receives only waste similar in character to the domestic sewage from a household.

(n) domestic waste,

(o) incinerator ash resulting from the incineration of waste that is neither hazardous waste nor liquid industrial waste,

(p) waste that is a hazardous industrial waste, hazardous waste chemical, ignitable waste, corrosive waste, leachate toxic waste or reactive waste and that is produced in any month in an amount less than five kilograms or otherwise accumulated in an amount less than five kilograms,

(q) waste that is an acute hazardous waste chemical and that is produced in any month in an amount less than one kilogram or otherwise accumulated in an amount less than one kilogram,

(r) an empty container or the liner from an empty container that contained hazardous industrial waste, hazardous waste chemical, ignitable waste, corrosive waste, leachate toxic waste or reactive waste,

(s) an empty container of less than twenty litres capacity or one or more liners weighing, in total, less than ten kilograms from empty containers, that contained acute hazardous waste chemical,

(t) the residues or contaminated materials from the clean-up of a spill of less than five kilograms of waste that is a hazardous industrial waste, hazardous waste chemical, ignitable waste, corrosive waste, leachate toxic waste or reactive waste, or

(u) the residues or contaminated materials from the clean-up of a spill of less than one kilogram of waste that is an acute hazardous waste chemical;

"hazardous waste chemical" means,

(a) a commercial waste chemical having a generic name listed in Part B of Schedule 2, other than a waste described in Schedule 2.2, or

(b) a mixture of a waste referred to in clause (a) and any other waste or material;

"ignitable waste" means a waste that,

(a) is a liquid, other than an aqueous solution containing less than 24 per cent alcohol by volume and has a flash point less than 61° Celsius, as determined by the Tag Closed Cup Tester (ASTM D-56-79), the Setaflash Closed Cup Tester (ASTM D-3243-77 or ASTM D-3278-78), the Pensky-Martens Closed Cup Tester (ASTM D-93-79), or as determined by an equivalent test method approved by the Director,

(b) is a solid and is capable, under standard temperature and pressure, of causing fire through friction, absorption of moisture or spontaneous chemical changes and, when ignited, burns so vigorously and persistently that it creates a danger,

(c) is an ignitable compressed gas (Class 2, Division D as defined in the regulations under the Transportation of Dangerous Goods Act (Canada), or
(d) is an oxidizing substance (Class 5, Divisions 1 and 2) as defined in the regulations under the Transportation of Dangerous Goods Act (Canada);

"incinerator ash" means the ash residue, other than fly-ash, resulting from incineration where the waste is reduced to ashes containing by weight less than 10 per cent of combustible materials;

"incinerator waste" means the residue from incineration, other than incinerator ash and fly-ash;

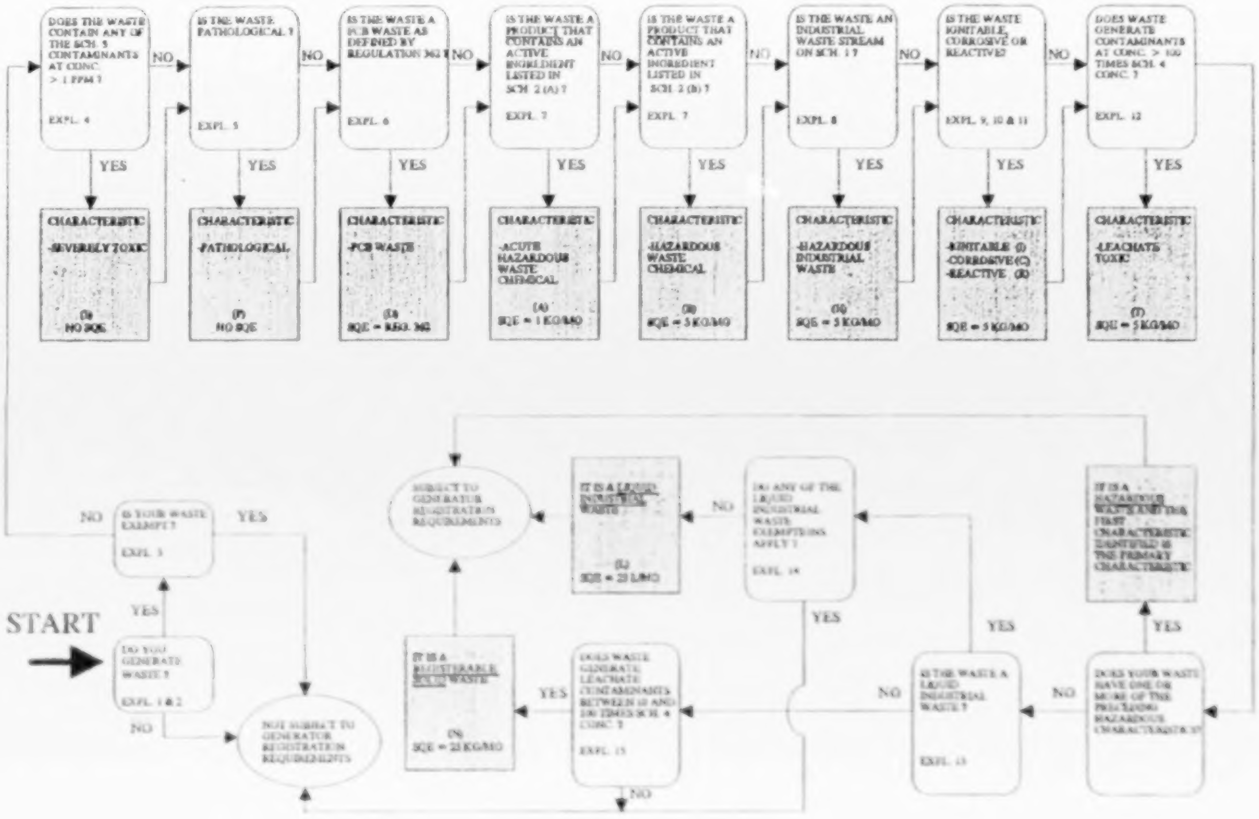
"individual collection system" means the collection of a householder's own domestic wastes by a householder and the transportation of such wastes to a waste disposal site by the householder;

"industrial waste" means waste from,

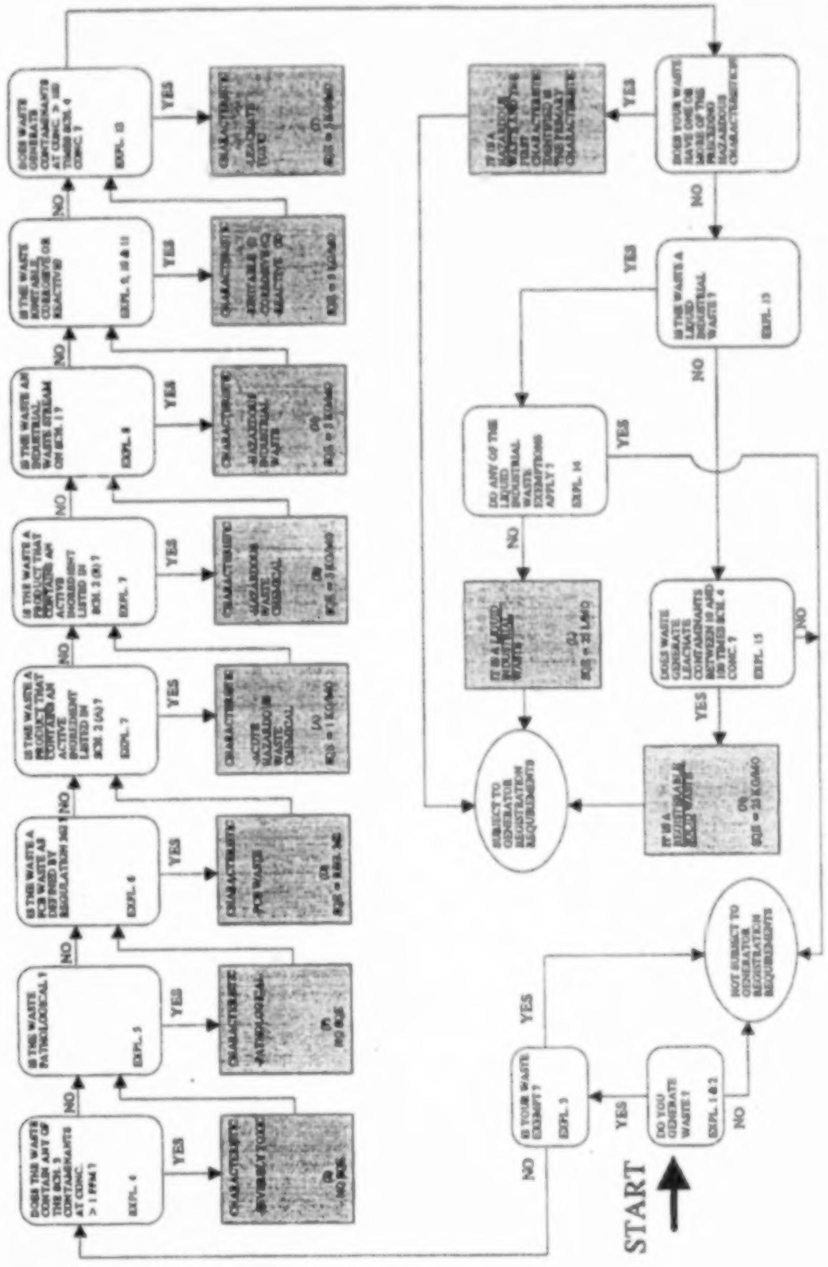
(a) an enterprise or activity involving warehousing, storage or industrial, manufacturing or commercial processes or operations,
(b) research or an experimental enterprise or activity,
(c) an enterprise or activity to which clause (a) would apply if the enterprise or activity were carried on for profit,
(d) clinics that provide medical diagnosis or treatment, or
(e) schools, laboratories or hospitals;

Appendix I

Waste Identification Flowchart


DOES THE WASTE CONTAIN ANY OF THE SCH. 5 CONTAMINANTS AT CONC. > 1 PPM ?
EXPL. 4
NO
IS THE WASTE PATHOLOGICAL ?
EXPL. 5
NO
IS THE WASTE A PCB WASTE AS DEFINED BY REGULATION 362 ?
EXPL. 6
NO
IS THE WASTE A PRODUCT THAT CONTAINS AN ACTIVE INGREDIENT LISTED IN SCH. 2 (A) ?
EXPL. 7
NO
IS THE WASTE A PRODUCT THAT CONTAINS AN ACTIVE INGREDIENT LISTED IN SCH. 2 (B) ?
EXPL. 7
NO
IS THE WASTE AN INDUSTRIAL WASTE STREAM ON SCH. 1 ?
EXPL. 8
NO
IS THE WASTE IGNITABLE, CORROSIVE OR REACTIVE?
EXPL. 9, 10 & 11
NO
DOES WASTE GENERATE CONTAMINANTS AT CONC. > 100 TIMES SCH. 4 CONC. ?
EXPL. 12
YES
CHARACTERISTIC -SEVERELY TOXIC (S) NO SQE
CHARACTERISTIC -PATHOLOGICAL (P) NO SQE
CHARACTERISTIC -PCB WASTE (E) SQE = REG. 362
CHARACTERISTIC -ACUTE HAZARDOUS WASTE CHEMICAL (A) SQE = 1 KG/MO
CHARACTERISTIC -HAZARDOUS WASTE CHEMICAL (B) SQE = 5 KG/MO
CHARACTERISTIC -HAZARDOUS INDUSTRIAL WASTE (H) SQE = 5 KG/MO
CHARACTERISTIC -IGNITABLE (I) -CORROSIVE (C) -REACTIVE (R) SQE = 5 KG/MO
CHARACTERISTIC -LEACHATE TOXIC (T) SQE = 5 KG/MO
START
DO YOU GENERATE WASTE ?
EXPL. 1 & 2
YES
NO
IS YOUR WASTE EXEMPT ?
EXPL. 3
NO
YES
NOT SUBJECT TO GENERATOR REGISTRATION REQUIREMENTS
SUBJECT TO GENERATOR REGISTRATION REQUIREMENTS
IT IS A LIQUID INDUSTRIAL WASTE (L) SQE = 25 L/MO
IT IS A REGISTERABLE SOLID WASTE (N) SQE = 25 KG/MO
DOES WASTE GENERATE LEACHATE CONTAMINANTS BETWEEN 10 AND 100 TIMES SCH. 4 CONC. ?
EXPL. 15
YES
NO
DO ANY OF THE LIQUID INDUSTRIAL WASTE EXEMPTIONS APPLY ?
EXPL. 14
NO
YES
IS THE WASTE A LIQUID INDUSTRIAL WASTE ?
EXPL. 13
NO
YES
DOES YOUR WASTE HAVE ONE OR MORE OF THE PRECEDING HAZARDOUS CHARACTERISTICS?
NO
YES
IT IS A HAZARDOUS WASTE AND THE FIRST CHARACTERISTIC IDENTIFIED IS THE PRIMARY CHARACTERISTIC

Appendix I
Waste Identification Flowchart


START
DO YOU GENERATE WASTE ?
EXPL. 1 & 2
YES
NO
IS YOUR WASTE EXEMPT ?
EXPL. 3
YES
NO
NOT SUBJECT TO GENERATOR REGISTRATION REQUIREMENTS
DOES THE WASTE CONTAIN ANY OF THE SCH. 5 CONTAMINANTS AT CONC. > 1 PPM ?
EXPL. 4
IS THE WASTE PATHOLOGICAL ?
EXPL. 5
CHARACTERISTIC PATHOLOGICAL
IS THE WASTE A PCB WASTE AS DEFINED BY REGULATION 362 ?
EXPL. 6
CHARACTERISTIC PCB WASTE
IS THE WASTE A PRODUCT THAT CONTAINS AN ACTIVE INGREDIENT LISTED IN SCH. 2 (A) ?
EXPL. 7
CHARACTERISTIC ACUTE HAZARDOUS WASTE CHEMICAL
IS THE WASTE A PRODUCT THAT CONTAINS AN ACTIVE INGREDIENT LISTED IN SCH. 2 (B) ?
EXPL. 7
CHARACTERISTIC HAZARDOUS WASTE CHEMICAL
IS THE WASTE AN INDUSTRIAL WASTE STREAM ON SCH. 1 ?
EXPL. 8
CHARACTERISTIC HAZARDOUS INDUSTRIAL WASTE
IS THE WASTE IGNITABLE, CORROSIVE OR REACTIVE?
EXPL. 9, 10 & 11
CHARACTERISTIC IGNITABLE CORROSIVE REACTIVE
DOES WASTE GENERATE CONTAMINANTS AT CONC. > 100 TIMES SCH. 4 CONC. ?
EXPL. 12
CHARACTERISTIC LEACHATE TOXIC
DOES YOUR WASTE HAVE ONE OR MORE OF THE PRECEDING HAZARDOUS CHARACTERISTICS
IT IS A HAZARDOUS WASTE
IS THE WASTE A LIQUID INDUSTRIAL WASTE ?
EXPL. 13
DO ANY OF THE LIQUID INDUSTRIAL WASTE EXEMPTIONS APPLY ?
EXPL. 14
IT IS A LIQUID INDUSTRIAL WASTE
DOES WASTE GENERATE LEACHATE CONTAMINANTS BETWEEN 10 AND 100 TIMES SCH. 4 CONC. ?
EXPL. 15
IT IS A REGISTRABLE SOLID WASTE
SUBJECT TO GENERATOR REGISTRATION REQUIREMENTS

Appendix J

East Taro Landfill Expert Panel: Responses to Mr. Carmen D'Angelo's Questions

QUESTION 1
Is there such a thing as a "nonhazardous landfill"?

Labeling a landfill "hazardous" and/or "non-hazardous" can be misleading because the terms hazardous and non-hazardous apply not to the actual landfill itself but rather to the type of waste it is authorized to receive. Thus the correct naming should be "Landfills designed and approved to receive hazardous waste"; and "Landfills designed and approved to receive *only* non-hazardous waste." Each type of landfill is required to be run according to the conditions specified in the Certificate of Approval. A landfill approved to receive hazardous waste will be expected to have either a higher level of natural attenuation or engineering than a typical non-hazardous waste landfill (e.g. with a thicker clay liner and/or multiple plastic and clay liners).

However well constructed, even a landfill approved to receive hazardous waste (in both the United States and Canada) will not receive hazardous waste in the form that has given rise to most of the problems in the past (e.g. they will not receive liquid hazardous waste such as barrels of organic chemicals).

A non-hazardous landfill, is designed to accept wastes that are, by regulatory definition, non-hazardous. A municipal solid waste landfill is an example of a non-hazardous waste landfill. Even so, these landfills can accept materials that can be harmful to humans and the environment. The intent of these landfills is to isolate and contain these wastes and any leachate or gases that may be generated. These types of landfills are now designed to very exacting standards to ensure that even the leachate from non-hazardous waste is properly managed and does not escape to the groundwater or surface water.

As for any risk posed by the landfill itself, the better the design and operation of a landfill, the less risk it presents. This point is touched on in much greater detail in subsequent responses to questions.

QUESTION 2
If there is such a claim that a landfill can be non-hazardous, what is the definition of a "Solid Non-Hazardous Commercial, Institutional and Industrial Waste?

Here again the label applies to the type of waste permitted to be deposited. The East Taro Certificate of Approval (No. A 181008) restricts the waste it may receive to "solid, non-hazardous commercial, institutional and industrial waste including petroleum contaminated soils." This includes[11] "... solidified/stabilized industrial wastes; industrial slags ...." The CofA also explicitly indicates that "No liquid industrial wastes, hazardous wastes as defined under Regulation 347, or putrescible waste shall be disposed of in the waste disposal fill area on the Site."

An important function of the regulations is to define key concepts such as "hazardous waste." The legal definition of hazardous waste is not identical to the meaning of the term as it may be used in everyday speech. In some respects the legal definition of non-hazardous waste is counter-intuitive.

Waste that is classified as "non-hazardous" may and often does include substances that could be toxic or harmful if they were released to the environment in sufficient quantities without appropriate treatment or control. There are many "contaminants" contained in non-hazardous waste, including heavy metals, some chemicals, asbestos, etc. Landfill sites are engineered to receive these wastes and manage them and the effluents that result from their decomposition in such a way that the risk they pose to humans and the natural environment is reduced to a negligible level or eliminated entirely.

QUESTION 3

Will quarry blasting have an effect on the integrity of the liner and/or leachate collection system?

VME Associates Ltd, an independent group of consulting explosive engineers, evaluated the potential effect of blasting on the Taro East Landfill liner as part of the Environmental Assessment[12]. They concluded that blasting would not have an adverse effect on the liner provided that the distance between the point of blasting and the liner exceeded 60m. The CofA added a "factor of safety" by specifying a minimum 100m separation distance. The expert panel has been advised by Taro that in fact the closest distance has been 120m. Independent measurements made by Golder VME on 13 April 2000[13] at a location 250m from the working face recorded a peak particle velocity of less than 4 mm/s which was less than 8% of the recommended limiting value of 50mm/s.

It is worth noting that the compacted clay liner and the plastic (geomembrane) liner and leachate collection pipes are all very plastic (as contrasted with brittle substances like rock and concrete) and hence are much better able to withstand short term accelerations due to blasting than, say, a brick house or an unreinforced concrete pavement. Based on the available evidence, there appears to be no reason for concern regarding damage to the liner or leachate collection system due to blasting. In the event that there had been serious damage, the effect would be detectable in terms of increased leakage to the Hydraulic Control Layer (HCL) and could be detected and controlled. In the extremely unlikely worst case scenario of damage to both the plastic (geomembrane) and compacted clay component of the primary liner, under long term operating conditions flow of water would be inward to leachate collection system. This would increase the amount of leachate that had to be collected but contaminants would still be contained by the hydraulic containment (hydraulic trap design).

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[11] Taro East Quarry Environmental Assessment, Design and Operations Report, Gartner Lee Ltd., January 1995, p. 4.

[12] Taro East Quarry Environmental Assessment, Quarry Blasting Impact Assessment, VME Associates Ltd., January 1995.

[13] Golder VME Ltd. letter Report to Taro dated 18 April 2000.

QUESTION 4

Is it safe to the environment and thus to human health, to locate a landfill on top of fractured bedrock where contaminants have been estimated to be present over the next 300 years?

This question really has two parts. In response to the second part of the question (the contaminating lifespan) the Panel's Report notes that the leachate is relatively benign in the context of typical landfill leachate and would require relatively little attenuation of health related parameters such as benzene, dichloromethane, cadmium, and lead to meet the provincial "Reasonable Use Guideline" at the site boundary. The maximum concentration of contaminants of particular concern to residents, such as cyanide and TCE, are at such low levels that even the maximum observed concentration is below the provincially specified drinking water objectives. With respect to these contaminants, the "contaminating lifespan" may be expected to be much less than 300 years.

The predicted contaminating lifespan[14] of 200-300 years has been calculated on the basis of a model which made assumptions about the chemical composition of materials going into the landfill, and then predicted how long it would take for enough of these chemicals to have leached out of the landfill for the remaining leachable amounts to reach acceptable levels. The two chemicals predicted to be the last to reach safe levels are sodium and fluoride. The concentration of sodium recently observed in the landfill leachate is substantially higher than that assumed in the model, however it is not clear what implications this has for the service life. If the total amount of sodium actually present in the landfill is the same as initially assumed in the model, then a higher leachate concentration will translate into a reduction in the contaminating lifespan to about 160 years. If there was an increase in the mass of sodium in the waste (it was initially taken to be .16% of the total mass) in conjunction with the increase in average concentration then the contaminating lifespan might be as long as originally predicted.

Fluoride does not appear to have been monitored according to the data with which we have been provided. This is surprising since fluoride is a critical contaminant (please see Glossary Appendix C) and is listed in the CofA - it appears to have been overlooked in monitoring. It would seem appropriate to monitor fluoride to provide insight regarding the contaminating life span assumptions related to fluoride.

Chloride was not considered a critical contaminant at the time of the EA for the East Landfill. Given the significant concentrations being observed in the leachate it is possible that chloride will become the most critical contaminant

Based on the available data, it would appear that the primary contaminants with a contaminating life span of the order of 300 years are sodium, chloride (common salt is sodium chloride) and, possibly, fluoride.

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[14] Taro East Quarry Environmental Assessment, Waste and Leachate Characterization Report, January 1995.

As for the siting of the landfill, the West Landfill was constructed in a fractured rock quarry without any engineered liner or leachate collection system. It has impacted on groundwater and, at present, these impacts are being controlled by pumping. In contrast, the East Landfill has a state-of-the-art barrier system with several levels of redundancy. Given the engineering mitigation measures, it is the Panel's opinion that this is a perfectly suitable site for a landfill of the type approved in the CofA. There is no reason to believe that the location of this landfill on fractured bedrock will have any adverse effect on human health (i.e., given the barrier system design for the East Landfill, there is no reason to believe that the impacts due to it being located on fractured bedrock will be any different than if it had been located in clayey till).

It is worth noting that most other modern landfills are either located over fractured bedrock, fractured till or a granular aquifer simply because geologically there are no alternatives. This landfill has the advantage that it (a) has a double engineered liner; and (b) can be operated as a hydraulic trap. In contrast a very large Municipal Solid Waste (MSW) landfill has been approved in fractured rock with hydraulic containment and no liner (i.e., the "Adam's Mine"), while another in a sand aquifer has only a single engineered liner (e.g. Keele Valley). The Halton landfill was approved after a lengthy hearing with only a single liner (if the till proved to be fractured, as it did) and hydraulic containment (in fact it was over-designed and constructed with the additional redundancy of a hydraulic control layer below the engineered liner). In this context it could be argued that the Taro East Landfill may also have been over designed given the standards and expectations at the time that it was designed; given the current controversy, this is indeed fortunate since the residents can at least be assured that the approved design is state-of-the-art.

QUESTION 5

Is there a comparable landfill where the liner has been proven not to fail? Subsequently, is there a comparable landfill where the leachate collection system has been proven over the lifespan of the contaminants?

There are several liners incorporated into the design of the Taro East Landfill and several levels of redundancy to the design. The geomembrane liner represents the first line of defence and is only relied upon in the design for the period of landfill operation (i.e., before the hydraulic control layer is pressurized). There is a considerable body of evidence that HDPE geomembrane will have a service life exceeding what has been assumed in the design (about 20 years). The MOE landfill standards allow a design life of 150 years for a similar primary geomembrane liner and 350 years for a secondary geomembrane liner[15].

While the plastic used in HDPE geomembranes has only been around for 40-50 years it is known that this type of plastic degrades very slowly. (For example plastic that has been monitored long term shows little evidence of significant degradation after 30 years [16].)

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[15] Ontario Regulation 232/98, Schedule 3.

[16] Brady, K.C., McMahon, W., and Lamming, G. (1994) "Thirty year ageing of plastics," Transport research laboratory, Project report 11, E472A/BG, ISSN 0968-4093.

Accelerated ageing tests[17] predict service lives for geomembranes at 25°C of 300 to 400 years. These tests also show that the lower the temperature, the longer the service life. Since there is minimal putrescible waste in the waste at the Taro East Landfill (compared to a municipal solid waste (MSW)landfill), the temperatures on the liner should be much lower than in a MSW landfill and hence the period of time that the geomembrane will remain functional is likely longer than the 150 years assigned for primary liners by the MOE. There is every reason to believe that it is more likely to be of the order of the 350 years assigned to the secondary liner. Thus there is a reasonable probability that the geomembrane will provide protection for the contaminating lifespan of the landfill (estimated by the proponent to be of the order of 300 years as noted earlier) even though the designers are only relying on this geomembrane liner for about 20 years (at which point the other safety design features take over.)

The second and third line of defence are the primary and secondary compacted clay liners. Ontario Regulation 232/98[18] ascribes compacted clay liners an unlimited service life. The liners at the Taro East landfill are 25% thicker than is required and can be expected to also have an unlimited service life. It should be noted that "clay liners" deposited by glaciers 10,000 to 12,000 years ago have a documented record of providing a low permeability barrier over at least 10,000 years while in contact with saline water[19]; it is reasonable to expect that an engineered liner constructed from similar materials but with a much higher level of quality control would do as well.

It is sometimes argued that "all liners leak" and in a sense this is true in that nothing is totally impermeable and hence even with a well constructed liner there is a small design flow of fluid through the liner. However the design of the Taro East Landfill is such that if there is a "leak" after closure of the landfill, it would be a leak of water **into** the landfill and **not** a leak of leachate out of the landfill due to the hydraulic trap design.

The leachate collection system consists of gravel and perforated leachate collection pipes. There is very little information regarding the service life of the primary leachate collection system in an industrial waste landfill (as opposed to a MSW landfill) however the probability of biologically induced clogging of the collection system is less than in a MSW landfill and it is not unreasonable therefore to assume that the service life would be longer than would be expected of a MSW landfill.

The hydraulic control layer is similar to the secondary leachate collection system described in Ont. Reg. 232/98 [20] and ascribed a service life of 1000 years. Since this layer consists of gravel isolated from the waste it should behave just like a coarse gravel aquifer and these have existed and "functioned" for thousands of years. Given the level of redundancy in the design it can be expected that the leachate can be controlled by one or more of the systems for the anticipated contaminating lifespan of the landfill. There is of course the need for funding to be in place to maintain, monitor and pump the system and to treat the leachate for this period of time.

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[17] Koch, R., Gaube, E., Hessel, J., Gongro, C., and Heil, H (1988) "Langzeitfestigkeit von Deponiedichtungsbahnen aus Polthylen," Mull und Abfall, Vol 8, pp. 348-361.

[18] Ontario Regulation 232/98, Schedule 4.

[19] Rowe, R.K., Quigley, R.M. and Booker, J.R. (1995). "Clayey Barrier Systems for Waste Disposal Facilities," E & FN Spon (Chapman & Hall), London, 390 pp.

[20] Ontario Regulation 232/98, Schedule 2.

QUESTION 6

What is the in-depth spectrum analysis of the leachate?

The Ministry of Environment establishes which parameters to monitor in the Certificate of Approval. These parameters need to be reviewed on a regular basis to ensure that new parameters of concern are added and parameters not required are dropped. For example, the US agency charged with establishing priority substances in terms of threat to human health (ATSDR -- Agency for Toxic Substances and Disease Registry) lists arsenic, lead and mercury as its top three priority substances. List B (Schedule C) of the Taro East Certificate of Approval which specifies the required parameters for leachate and groundwater monitoring includes lead but not arsenic or mercury. Surface water monitoring (Schedule D) requires all three parameters.

The 1999 Annual Report includes more monitoring than required by the CofA. For example arsenic levels are reported in groundwater and surface water; lead levels in air, leachate, groundwater, and surface water; and mercury in surface water. The levels of mercury in the surface water were very low. However, this is an example where continued enhanced testing of the leachate may be of value to demonstrate the expected low levels of mercury.

Overall, testing done to date indicates that the leachate is generally comparable to leachate from other landfills except that levels of many problem chemicals are lower in the Taro leachate.

The Panel has made further recommendations in the final report for extra sampling to further characterise both the leachate and air emissions.

QUESTION 7

Can leachate be treated at a municipal sewage treatment plant?

Leachates are treated at many municipal plants, for example Waterloo (Erb St landfill), Windsor Little River (Maidstone landfill trials), Niagara's Baker Road WPCP (Park Road landfill). Tests done at the first two of these treatment plants indicated that the plants could meet their "conventional" CofA's. Maidstone leachate chloride concentration, which is similar to Taro, was shown not to have a deleterious effect on the Little River plant at a volumetric load of about 0.5%. CRA's (Conestoga Rovers and Associates) work with respirometry (see Glossary Appendix A) strongly suggests that the Woodward plant can handle Taro leachate.

Given the capacity of municipal sewage treatment plants to handle complex wastewaters, landfill leachate is often directed there for treatment. Many organics and metals will be removed by biochemical oxidation or adsorption in the biosolids. Similar processes are often used for complex industrial wastewaters to degrade difficult pollutants.

The US EPA[21] has concluded that national pre-treatment standards are not necessary for landfills. EPA found that Publicly Owned Treatment Works (POTWs) adequately treated pollutants in landfill wastewater, and only a very small quantity of pollutant loads discharged by landfills to POTWs are further discharged to rivers, streams or estuaries. Furthermore, EPA concluded that wastewater discharges from landfills do not cause operational problems (such as biological inhibition or sludge contamination) for POTWs.

QUESTION 8

What are the adverse effects to short term and long term exposure to leachate?

Leachate is the liquid waste which drains off of landfill sites. It *can* contain toxic chemicals but it is not always toxic. It *can* also create human health problems if there is a pathway of exposure through ground or surface water, if it is volatilized into air, or if it is put in contact with soil that then comes into contact with humans.

The leachate from the East Landfill is low in contaminants and currently is trucked off site. There is a low risk of pathway exposure (and a low risk of contaminants within the exposure) through handling by employees, accidental consumption on site, volatization into air through the collection pond or spraying or a potential truck spill.

The leachate from the West Landfill is low in contaminants and currently is discharged in the municipal sewer system for treatment. There is a low risk of pathway exposure and a low risk of contaminants within the exposure through handling by employees, accidental consumption on site, volatization into air through the collection pond or a potential sewer escape.

The leachate from landfills is monitored for a significant number of contaminants as required by the CofAs. In addition the air is monitored for TSP, gases as well as VOCs. The panel has reviewed this list and is making recommendations as to an ongoing monitoring protocol to ensure that the leachate receives appropriate treatment and handling.

The potential health effects of an accidental consumption of East Landfill leachate was calculated (using a risk assessment approach) in the Cantox 1995 EA report on request by the Study Group. This analysis was subsequently updated in the Cantox 1998 and 1999 reports. Accidental consumption of West Landfill leachate has not been assessed. Workers are expected to use protective devices in their handling of leachate.

QUESTION 9

What exposure hazards exist to the community with the practice of recirculating leachate?

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[21] EPA Final Effluent Limitations Guidelines and Pre-treatment Standards for the Landfills Point Source Category Rule 1.

The leachate from the East Landfill is low in volatile organic compounds (VOCs) currently. The risk of effects from spraying is estimated to be very low although a risk assessment has not been done. As an additional precautionary measure, the Panel recommends that the practice of recirculating leachate by spraying should however be discontinued. If Taro decides to recirculate the leachate, they should use a trickle method rather than spraying to reduce the potential for VOC release

QUESTION 10

Is it feasible to expect that trucks can continuously remove leachate from the site over the life span of the landfill and the contaminants within?

It is certainly feasible to regularly truck the leachate to a treatment plant for the contaminating lifespan of the landfill. However in the Panel's opinion it would make more sense to send the East Landfill leachate by pipe to the Woodward water treatment plant as is currently done for the West Landfill Leachate. The Panel is of the opinion that, subject to confirmatory tests, the Woodward plant will be able to handle the small incremental volume from Taro East leachate (a small fraction of the volume of the Taro West leachate). This would eliminate the need to truck the leachate, and would therefore be much more environmentally sensible. When one considers both the truck fumes and the potential for a road accident it is difficult to justify trucking to a smaller treatment plant on the Grand River. The Region is moving ahead to upgrade Woodward to reduce bypasses and to give improved treatment. This will take time and money but a contribution from the Company (in recognition of costs saved from no longer trucking the leachate to Brantford) would be beneficial to all parties.

The Panel has also recommended operational changes at the Taro site and the treatment plant to avoid leachate being sent to the sewers during treatment plant bypass conditions. It would be ideal if this practice could be extended to other landfills, where possible.

QUESTION 11

What is Ecosafe? What stabilizing process is used during EcoSafe? Has it been proven that EcoSafe can render hazardous waste into non-hazardous waste over the short and long term? If EcoSafe does work, what specific hazardous wastes can it treat and what hazardous wastes can it not treat?

Ecosafe is a process for "stabilizing" waste. In some instances wastes that are characterized as "leachate hazardous" can be treated with the Ecosafe process so that they cease to be leachate toxic (i.e., will pass the leachate toxicity test). The amended CofA of the Imperial St Facility (which uses the Ecosafe process to treat some wastes) required the Company to have independent consultants review the Ecosafe process. Their report reached the following conclusions:

1. Stabilisation technology is a common hazardous waste management technology that is practised throughout the United States;
2. Regulations in the United States and Ontario have been amended to update standards for managing hazardous wastes;

3. Stabilisation is effective at managing risks associated with some hazardous wastes;
4. Stabilisation technology provides substantial benefits that protect the natural environment;
5. Stabilisation technology provides substantial economic benefits to Ontario industry that improves their profitability and competitiveness;
6. Ecosafe is a systematic process that consistently reduces the environmental hazard of inorganic contaminants;
7. The Ecosafe chemical conversion processes are common and well-known reactions that effectively reduce the hazard of many inorganic contaminants;
8. The Ecosafe encapsulation processes are well-known reactions that effectively reduce the mobility of inorganic contaminants; and
9. The chemical conversion and encapsulation processes used in the Ecosafe process are well suited to the non-hazardous landfill environment.

A member of the Panel Expert in turn reviewed the Ecosafe Report and reached the conclusion that based on the data presented the Ecosafe process is an effective and very useful technology for the treatment of leachate toxic wastes. The Panel and the MOE have both expressed some concerns about how thoroughly the Ecosafe process mixes the wastes with the stabilizing agents.

QUESTION 12

How much (quantity) waste, that the company claims has been stabilized and rendered non-hazardous, by EcoSafe (or any other waste stabilizing process) has entered the Taro East Landfill?

This question was addressed by the Company's staff, who stated that they are unable to provide the Panel and/or the CLC with an exact quantity of wastes that have undergone the EcoSafe stabilization process because some of the waste may have been merely solidified, not stabilized. Their best estimate is that the total wastes stabilized or solidified and deposited in the Taro East Landfill between December of 1996 and September of 1998 were just under 90,000 tonnes.

QUESTION 13

What are the long-term effects of continuously utilizing large amounts of groundwater to dilute the leachate?

The East Landfill leachate is not being diluted by groundwater at all, and there is no reason to do so in the future.

The West Landfill leachate is being combined with the groundwater pumped from the containment wells, with the combined mix being sent to the Woodward Street Plant for treatment. This is standard practice for landfills where containment pumping is occurring. The containment pumping is needed to keep the West Landfill leachate from escaping and contaminating groundwater from the landfill to the Niagara Escarpment. The containment pumping itself has, however, led to a measurable salinization of groundwater downgradient of the site, as the pumping removes shallower and fresher groundwater.

The long-term effects of such pumping related to the West Landfill (not the East Landfill), are that there will be a long-term salinization of groundwater downgradient of the Taro properties. This affects groundwater quality on adjacent properties and could eventually extend as far as the Niagara Escarpment. While groundwater quality on adjacent properties was marginal to start with, it is now worse as a result of the containment pumping and it will remain that way for the long term. The Panel is recommending that enhanced groundwater testing be done; and that compensation be provided to nearby residents who have suffered losses from the degraded water (if such losses have occurred).

QUESTION 14

What are the overall effects on groundwater relative to the landfill?

The East Landfill is well enough designed that there may never be significant effects on groundwater.

The West Landfill was not well designed and, since it does not have either a natural or engineered barrier system, it has been leaking leachate since it went into operation. This leachate requires containment pumping to keep it from contaminating downgradient properties, and the effects of this pumping are the long-term salinization of groundwater described in the response to Question 13 above. Some leachate may have escaped before the containment pumping system went into effect - this is discussed in more detail in the response to Question 15 below.

QUESTION 15

Is the Taro West Landfill plume having an effect on the groundwater and/or the Taro East Landfill?

The West Landfill leachate plume is migrating under the East Landfill, where it is collected by pumping well M4. It is not having any effect on the overlying landfill, nor should it in the future.

The West Landfill leachate plume has had an effect on groundwater. Since the West Landfill does not have proper leachate collection facilities, the leachate generated by the landfill migrates into the underlying groundwater system.

This leachate impacted groundwater would have started migrating downgradient (toward the Niagara Escarpment) after escaping from the landfill. A series of containment wells were installed starting in 1992 to stop this leachate migration. They are still in use today and will be needed throughout the contaminating lifespan of the West Landfill. Once the landfill is capped, they may not need to be pumped as heavily, but they will need to be pumped over the long term.

There is some question whether any leachate made it beyond the containment wells and is now migrating toward the escarpment. It appears that groundwater quality downgradient of the Taro properties has been negatively affected by the operations on those properties. This change in water quality reduces its usefulness as drinking water (for example salinization makes the water taste salty) however there is no evidence that this change in water quality has had any adverse health impacts.

It would take considerable research to try to conclusively distinguish between the effects of salinization (which we know is occurring) and leachate migration from the time before the containment wells went into operation (the extent of which is very difficult to determine after the fact), but it really doesn't make much difference. Regardless of what caused the negative effects on groundwater quality downgradient of the Taro properties, it was activities associated with the West Landfill which caused them and the Company is responsible for dealing with any issues which arise as a result.

QUESTION 16

What short and long term adverse health effects exist with exposure to leachate, landfill gases from both the Taro West and East Landfills, and truck traffic.

The discussion of the leachate health effects is given in the response to Question 9.

Truck traffic can increase the air contaminants of gases, metals and particles. There is one air monitoring station on the incoming haulage route and one on the outgoing route. The air monitoring completed to date indicates that at various times levels of total particles (dust) have exceeded air quality standards but VOCs and metals are all within accepted standards. As noted above, if the practice of trucking East Landfill leachate off site is discontinued in favour of discharging this leachate to the sewer system, truck traffic impacts will be reduced accordingly.

The panel is recommending a revised air monitoring protocol to include small particles and other specific contaminants, and the inclusion of more air monitoring stations to assess the distribution of exposure. The Panel is also recommending investigation of the feasibility of conducting a health study to explore respiratory health concerns around the landfill.

QUESTION 17

As each truck dumps wastes into the landfill (from either the processing site or directly from the waste generator), is the waste homogenous? If not homogenous, is random sampling of a truck sufficient to analyze the characteristics of the wastes?

The wastes in landfills are seldom homogeneous. Different waste streams come in regularly, each bringing new varieties of wastes.

There is great public concern about the issue of whether stabilised waste deposited in the East Landfill was not uniformly mixed; or whether the landfill contained a small quantity of what would otherwise (were it not such a small quantity[22]), be classified as hazardous waste; resulting in the formation of "hot spots" which may now or in the future pose environmental problems. However, even in the event that hot spots are present in the landfill, problems are unlikely for the following reasons:

1. If the problem chemicals in a hot spot are chemically bound to the wastes with which they were landfilled with and stay where they are (i.e., if they are "immobile"), then there is no problem. They are inside a modern, well-designed landfill, which is as secure a place as any for the disposal of such chemicals.
2. If the problem chemicals in the hot spot become "mobile" as part of the landfill's leachate, then they will travel downward with the leachate (drawn by gravity through other wastes in the landfill). As they move through those other wastes (which will be quite different in composition from the hot spot), they will tend to become immobised again in the landfill, i.e., get attenuated out of the leachate.

Attenuation is a name given to a series of physical, chemical and biological processes which serve to dilute and "filter out" – and in the case of many organic chemicals, biologically breakdown – a given chemical as it travels through a medium (in this case, the landfill). Only in cases where the hot spot is massive or where there are significant quantities of other wastes in the landfill also containing the problem chemicals, will they **not** get attenuated. In those cases, they will be present in the leachate when it reaches the base of the landfill, but will be blocked by the barrier system, and collected by the leachate collection system. In those cases sampling of the leachate will detect the problem chemicals. Once they are detected, any necessary measures to deal with them can be developed.

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[22] There is evidence that one truckload of waste samples from which did subsequently test as hazardous was irretrievably deposited in the landfill. The comments about "hot spots" help explain why this one truckload is unlikely to cause serious problems.

As discussed in detail elsewhere in the report, the sampling to date has not indicated that there are significant concentrations of problem chemicals in the leachate which would be indicative of large hot spots or large-scale dumping of hazardous wastes. On the contrary, the leachate from the Taro East Landfill contains less of such problem chemicals than many other landfills in Ontario.

Random sampling of a truck will be sufficient to analyze the characteristics of the wastes for the purposes of determining whether the wastes going in are hazardous or not. The key in terms of ensuring that the sampling fulfils its purpose is to ensure it is truly "random." There should be no notice necessary or provided, so that those doing the sampling simply come in and take the samples where and when they choose.

QUESTION 18

Given that the company claims that the landfill is engineered and thus the liner's location can be established, and given that deep core sampling has been requested by the community, what protocols are required for deep core sampling?

Neither Canada nor the United States currently has a protocol in place for "deep core" sampling to characterize wastes in municipal or industrial waste landfill facilities. The Panel has undertaken an extensive literature search as well as conducted inquiries with the relevant authorities and has found no jurisdictions with guidelines or a regulatory regime in effect to deep core sample emplaced waste. Ontario's current regulatory structure seeks to protect the integrity of our environment and the public's health by monitoring and regulating what goes in to the facility and what comes out of the facility in the form of air emissions or liquid effluents (leachate).

There are protocols for sampling contaminated soil, however these are really not appropriate to a landfill (which is often the destination for contaminated soil).

Deep core sampling would be an imperfect tool at best for characterizing the waste in this or other landfill facilities. As mentioned in the answer to Question 17, the small quantities exemptions section of regulation 347, whereby a generator is legally allowed to dispose of small quantities of what, in larger quantities, would be classified as hazardous waste, poses one difficulty for analysis and interpretation of sampling results. If landfill core sampling revealed a "hot spot" of "hazardous materials," given the small quantities exemption, there would be no way of knowing whether this waste was emplaced "legally" as its mere presence would be no indication of how it found its way into the facility.

In addition, when a substance is landfilled, in some instances it undergoes a number of physical, chemical and biochemical processes and reactions by which its original form and composition is altered a number of times and in a number of ways. Compounds within the wastes, once they have been deposited, can disassociate leaving molecules and free ions that can adsorb and/or bond themselves with other elements and form new and different compounds. Thus landfill sampling would not reveal accurately what went into the Taro Landfill. The effective method for determining whether hazardous wastes went into the landfill is to have sampled the waste before it went into the landfill.

The US EPA does not advocate the use of core drilling. Interviews with both MOE officials and Michigan DEQ staff revealed that they are not aware of the existence of any protocols allowing for the deep core sampling of landfill facilities nor were they aware of any facilities at which landfill sampling was done for the purposes of determining whether hazardous landfill regulations have been broken.

Landfill sampling is not a sort of geological MRI, which can locate and identify all the "hot spots" of hazardous waste in a landfill. On the contrary, due to the hazards caused by its use and the questionable efficacy of the results, the USEPA recommends core sampling only be undertaken, "for known hot spots…for which documentation and/or physical evidence exists to show their presence and location." (USEPA 1990a)

Under USEPA regulations, core sampling is normally used for the purposes of remediation and is primarily directed at the sampling of contaminated soils rather than landfills.[23] When there is a question of a landfill facility with hot spots, "The industry standard and the USEPA presumptive remedy for remediation of large municipal landfills with PCB or other hazardous contamination is containment." Containment means that the solid waste remains in its original location, but physical contact with contaminants is restricted and groundwater contamination is prevented. In fact, the USEPA further acknowledges that deep core sampling can be a hazardous activity as it is, "…(an) inherently difficult and risky operation in a mixed refuse industrial waste environment."

To sum up: even if some sort of sampling of the East Landfill were undertaken, there is no available framework of standards (or findings from other landfills) with which to compare the results in order to interpret their significance. Given that materials in landfill undergo changes, how can the results of analysis of the excavated materials be properly interpreted? If for example the excavated waste material were subjected to a leachate extraction procedure, and if the material tested as "hazardous," would this constitute a disturbing finding warranting remedial action; or merely a normal phase in the chemical evolution of non-hazardous waste, a transformation which the landfill is carefully designed to manage?

In the absence of a body of scientific knowledge and previous practice around the sampling of materials in landfills, sampling of the East Landfill would not answer the question raised in a recent Hamilton Spectator editorial which argued that sampling is "still needed": "Could it [hazardous waste] be buried there but not presently having an effect on emissions?." The best way to answer the concern underlying this question is through ongoing sampling of air emissions and leachate.

What happens if the emissions from a landfill indicate the presence of seriously harmful pollutants? Or if there are indications of waste being deposited contrary to CofA conditions? Or if test results indicate harmful off-site impacts? Should the MOE revise and extend the landfill monitoring paradigm by developing a "Waste Site Intervention Protocol" that would specify the "triggers" that would lead to a landfill sampling exercise? The MOE would need to undertake a major program of research and standard-setting to introduce such a protocol. It is not evident that such a protocol is needed for the Taro East Landfill, however the Panel has recommended that the MOE explore this issue for the possible occasion (not necessarily for the Taro East Landfill) when it might be desirable to have such a protocol

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[23] The Panel was made aware of an instance where the Bethlehem Steel Company used core sampling in an effort to obtain a "de-listing" of one of its landfill sites in Lackawana New York. In this case the landfill (which started operations in 1967) had received a homogeneous waste stream containing hazardous wastes from a single steel plant; and the contaminants of concern were well known in advance. The company was the proponent of this approach. Yet it took nearly 7 years to reach agreement on the sampling and analysis protocols to be followed.

QUESTION 19
Given that a substantial amount of asbestos has been landfilled, what are the risk factors of asbestos exposure?

The East Landfill is able to accept asbestos waste, as it is not considered "hazardous" in the definition of Regulation 347. There are explicit requirements for the handling of asbestos waste (Section 17, Regulation 347). The CLC and the environmental inspector have raised concerns on handling of asbestos. Although the East Landfill has received large amounts of asbestos in the past, this has reduced significantly and the amount expected in the future is low as asbestos can only be received from Hamilton-Wentworth generators. The Panel recommends that the MOE inspector inspect and report asbestos compliance with Regulation 347 routinely in his/her monthly report.

QUESTION 20
What biomarkers should be utilized for an ongoing community health study?

Biomarkers are defined in three subclasses:

- **Biomarkers of exposure:** these indicate whether exposure has occurred, and consist of measurements of chemicals (including metabolites) or products resulting from the interaction between the chemicals and an endogenous substance in body fluids, tissues or cells. An example would be a heavy metal concentration in blood.
- **Biomarkers of effect:** these are morphological, physiological or biochemical changes that have occurred as a result of exposure to substances foreign to organisms (xenobiotics). An example is changes in kidney function as a result of occupational cadmium exposure.
- **Biomarkers of susceptibility**: any factors, usually intrinsic or genetic, that may result in increased response to exposure. Susceptibility biomarkers can help to explain inter-individual variations seen in response to exposures." An example is certain enzyme systems are genetically determined which may influence an individual's response to contaminants.

In this formal sense, biomarkers can be useful in community health studies where there is clear evidence of a source, pathway and contaminant and a scientifically valid test to measure individual exposure, effect or susceptibility to that contaminant. The concept of biomarkers has expanded to also include any direct, as opposed to predicted, measure of human or animal health which indicates presence or absence of current or future health problem. Research into biomarkers is required to inform future decisions about their use.

QUESTION 21

Wastes are imported into the Region and processed. The company then claims that the waste landfilled are generated within the Region. Is the generator of wastes the last agent that handled the wastes prior to being landfilled or the agent that first produced the original waste?

According to Ontario regulations, the "generator" is the last agent to handle the waste. Thus wastes imported into the Hamilton-Wentworth region from outside the region are classified as "locally generated waste" if they are sent from the receiving agent to another facility in the region. This is precisely what happened with the CyanoKEM wastes.

They were sent first from Detroit to Parkdale (which is licensed to receive wastes from anywhere) where they were mixed with other wastes and were then sent on to Imperial St for stabilization using the "Ecosafe" process. They then went (properly classified as "locally generated waste") on to Taro for disposal.

The Company stated in the in the EA for East Taro that they planned to send to Taro wastes from outside the region that had been processed in local facilities:

> The purpose of our proposed undertaking ...[is to] continue to respond to the opportunity it has to meet the needs of its customers in the Hamilton-Wentworth Region who require disposal service for solid non-hazardous industrial commercial and industrial waste including the residue of waste brought into Hamilton for recycling and processing by Philip Environmental Inc. (page 1 Jan 26, 1995 letter to Minister Wildman).

The EA document emphasized the local need[24] and reported concerns expressed by the Study Group[25] and the general public[26] about waste coming from outside of the Region.

The Provisional Certificate of Approval states:

> Only wastes generated within the geographical boundaries of the Regional Municipality of Hamilton-Wentworth may be received for disposal at this Site. This includes materials originating outside of the Regional Municipality of Hamilton-Wentworth but which are processed within the Region.

Taro provides a summary of waste acceptance in its annual report using the categories: "Dofasco," "Philips Operations" and "Other Sources from Within Hamilton-Wentworth."

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[24] EA Volume 1 p. 9 "Taro's opportunity is to provide a facility to landfill 400,000 to 500,000 tonnes/year of solid non-hazardous IC&I wastes generated within the Region of Hamilton-Wentworth for the 20 year planning period." This implies locally produced waste.

[25] For example EA Volume 1 p. 52, "Others were concerned about waste from outside the Region coming into the Region."

[26] EA Appendix I-Q-I Example: "Why should we receive waste from other Regions"? Answer "Philips imports IC&I wastes from other parts of Ontario as a raw material input to its by-product development business, similar to other local industries importing raw materials to their production facilities."

However, the reporting of the waste received does not allow for straight forward assessment of how much waste is locally produced, how much is classified as local because it is imported from outside the region but then locally processed, and how much is actually produced locally as a residual of recycling.

Some of the confusion on this issue perhaps arose from ambiguity around the term "processing." While the Ecosafe treatment clearly constitutes processing, there are indications that some wastes were merely weighed and then re-shipped. An MOE "Audit"[27] of the Taro operations contained the following comment:

> During the inspection period, waste generated outside the Region of Hamilton Wentworth was received at this site, weighed and shipped to the Taro East Landfill for final disposal. Waste materials to be deposited at the Taro landfill must either originate in the Regional Municipality of Hamilton-Wentworth or be process residues from Philip operations in the City of Hamilton, to be considered within the Taro service area. It has been interpreted and conveyed to the company that waste materials must be physically or chemically changed at a transfer/processing site before it would be considered process residues and eligible for deposit at the Taro landfill. The practice of driving loads of waste over the scales at the Brant St. site for the purposes of changing the generator of the waste is not considered an acceptable practice. (p. 12)

Another source of controversy around this issue stems from a difference between U.S. and Ontario law. Under Ontario law, once an authorized agent or facility has received waste from a previous generator, the new agent takes on legal responsibility for the waste. Under U.S. law, however, the original generator of any hazardous waste remains liable throughout the "lifetime" of the waste, wherever it is sent for processing or disposal. Since in the case of the CyanoKEM waste, Philip was the owner of all facilities involved, the jurisdiction differences had no impact on the liability issue.

The Panel recognizes that the confusion around the service area has been a source of frustration and to some degree mistrust. This issue is one that may have been clarified during a full or focused hearing had there been one. The Panel also recognizes that changes in economic production within and outside of the Region as well as the changing technology of recycling means that calculations of local need completed for the EA may no longer apply to the present circumstance.

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[27] The audit revealed one other CofA compliance issue: "During the audit, the site was inspected eighty six (86) times and thirty (30) off-site inspections were conducted. The inspections revealed two (2) compliance issues with Certificate of Approval. The first was the failure of the company to record the licence plate numbers of vehicles entering the site. The second related to the company receiving a waste material directly from a site in Weston, Ontario, contrary to the service area restriction listed in the Taro CofA.

Actions/Recommendations

The company was advised of their omission regarding recording of licence plates and have corrected that problem. The service area issue was handled in the same manner. As the material in question was asbestos it was determined that the environment would be better served by leaving the material in the landfill to prevent the further risk of exposure by the staff at the landfill. Auditing and sampling of waste streams entering the landfill are to be continued at the same frequency." (p. 7)

QUESTION 22

Is $10,000 per annum adequate to support the CLC in terms of administrative support, legal conusel, and the ability to retain consultants to review company and government reports (as outlined in the Certificate of Approval)?

The Panel recommends major changes (including increased funding) to strengthen the CLC and CLC process.

QUESTION 23

Are the provisions within the Certificate of Approval adequate to properly regulate the Taro East Landfill?

The Panel considers that in general the provisions within the Certificate of Approval are adequate to properly regulate the Taro East Landfill. However, the Panel has made a number of additional recommendations relating to landfill operations and monitoring, the design and construction of future phases, and the resources, membership and mandate of the CLC. The MOE will have to determine whether revisions to the CofA are required to implement these changes.

Appendix K
Summary of Recommendations

8.1.1 Landfill Sampling

The Panel recommends that the Ministry of the Environment undertake a limited mass spectrometric study of the leachate from the Taro landfill and from 3 other industrial waste facilities for comparison. Leachate samples and emitted gas samples (cartridge) should be analysed by open scan mass spectrometry at high sensitivity.

The Panel recommends that MOE also undertake a number of samples at other landfills (some non-hazardous industrial and some municipal solid waste) for comparative purposes.

The Panel does recommend that MOE study the advisability and feasibility of developing such a protocol provided that this review is set in the context of an overall review of landfill regulations, and that it takes account of the various other recommendations set out in this Report.

If this review by MOE does result in the development of landfill sampling protocols; and if the CLC subsequently decides that appropriate sampling of the East Landfill (based on any protocols developed by MOE) would improve public understanding and confidence, and hence requests that East Landfill sampling be carried out, then the Panel would support this decision (assuming of course that precautions are taken to ensure that the environment, human health and the integrity of the landfill liner are protected).

8.2 Has The Landfill Been Well Engineered?

It is recommended that the designers consider the suggestions made in Appendix D in future design and construction activities related to the Taro East landfill.

8.3 Is the Landfill Harmful to Human Health or the Ecosystem?

8.3.1.2 Leachate Characteristics

It is recommended that a full scan that includes an examination for organic compounds, especially synthetic compounds that have been of concern in hazardous, industrial and municipal waste leachate (including PCBs, furans and dioxins such as 2,3,7,8 tetrachloro-dibenzo-p-dioxin (2,3,7,8-TCDD)), be conducted once a year. It is also recommended that arsenic be added to the list of parameters monitored and that all parameters specified in the CofA be monitored (e.g. fluoride has been missed).

8.3.3.1.1 The Woodward Avenue WWTP

The Panel strongly recommends continuation (and if possible acceleration) of any necessary upgrades to the sewer system and the Woodward Avenue WWTP by the City to avoid these bypasses.

The Panel recommends that the WWTP and Philip develop a notification system under which the Company will hold back the leachate at the landfill during by-pass events

The Panel recommends that a study be undertaken to examine whether the addition of Taro East landfill leachate to the Woodward WWTP would or would not have a negative impact with regard to treatment of conventional or specific organic and inorganic compounds.

8.3.3.3.1 The Chloride Issue

The Panel recommends that any discharge of East Landfill leachate should be subject to the following conditions:

a) The impact of the Taro West and East Landfill leachate on the Woodward Avenue WWTP should be evaluated through experimental pilot plant tests together with scans for metals and trace organics removals and accumulation in biosolids. Discharging of East leachate to the Woodward WWTP should only occur if these tests show that is acceptable.

b) In lieu of a chloride pre-treatment plant (and given savings realized by not building a plant and by eliminating the trucking and handling of leachate off-site), the Company should provide acceptable funding (to be negotiated with the Region) for use of the municipal sewer and WWTP. This funding should be used to assist with the upgrading of the Woodward WWTP.

8.3.4 Summary of Leachate Recommendations

1. The Company must ensure continued long-term commitment for leachate collection, characterization and treatment. This must be guaranteed in some secure way in the future and for as long as needed (i.e., hundreds of years).
2. The Panel strongly recommends continuation (and if possible acceleration) of any necessary upgrades to the Woodward Avenue WWTP by the City to accommodate the leachate and avoid bypassing the plant.
3. The Panel recommends that the WWTP and the Company develop and implement a notification system under which the Company will hold back the leachate at the landfill during by-pass or upset events.
4. The Panel recommends that the practice of recirculating leachate by spraying should be discontinued. If the Company decides to recirculate the leachate, they should use a trickle method rather than spraying to reduce the potential for VOC release.

5. The Panel recommends that the current Sewer Use By-Law limits and policies for chloride and sulphate be reviewed by the Region, and that whatever decision is made with respect to the chloride and sulphate limits it should be applicable to all sewer users and uniformly applied across the Region. As a pre-requisite, the current Region Sewer Use By-Law limits and policies for chloride and sulphate would need to be amended, such that East Landfill leachate could be discharged to the sewer system in compliance with the By-Law.
6. The Panel recommends that any discharge of East Landfill leachate should be subject to the following conditions:
    a) The impact of the Taro West and East Landfill leachate on the Woodward Avenue WWTP should be evaluated through experimental wastewater treatment pilot plant tests together with scans for metals and trace organics removals and accumulation in biosolids. Discharging of East leachate to the Woodward WWTP should only occur if these tests show that is acceptable.
    b) In lieu of a chloride removal pre-treatment plant (and given savings realized by not building the plant and by eliminating the trucking and handling of leachate off-site), the Company should provide funding (to be negotiated with the Region) for using the sewer system.
7. Leachate should be properly managed at the Taro site to prevent the leachate from causing odour problems.
8. A one-time triple split sample analysis should be completed for all CofA parameters by three certified labs to verify the quality of the Taro leachate analyses to assure the CLC that the results are scientifically valid

8.3.8 Recommendations Regarding Groundwater and Surface Water Issues

1. The overlaps, confusion and inconsistencies between monitoring programs for the quarry and the landfills should be eliminated, by developing a unified monitoring program.

   Assessment and monitoring of local groundwater and surface water quality should look at the cumulative impacts of all Taro operations.
2. The following measures should be implemented to deal with the degradation of groundwater quality downgradient of the Taro landfills:
    a) There should be quarterly monitoring of groundwater quality downgradient of the landfills, at springs T-B and A-1 through A-8 along the Niagara Escarpment. Monitoring should be for the list of "general" parameters and "major ions" specified in Schedule C of the East Landfill's Certificate of Approval.
    b) The Company should offer to cover the costs of annual third party domestic well water quality monitoring for residents living downgradient (north) of the landfills, provided that the results of such sampling are made available to the CLC.

c) The Company should install at least two additional nests of monitoring wells between the Taro landfills and the Niagara Escarpment, at locations to be determined in consultation with the CLC. These wells should be added to the regular groundwater monitoring program for the landfills.

Where the CLC has concerns that groundwater quality on downgradient properties to the north of the Taro landfills may have been degraded as a result of the landfills, this should be reviewed by independent experts (selected by citizen members of the CLC) to determine whether degradation has occurred and whether compensation is warranted. If the experts come to the conclusion that compensation is warranted, the Company should negotiate the level of compensation with the property owner(s) with binding arbitration being used if needed.

3. If the area northwest of the West Landfill is developed as a sports park, then storm water management plans for the capped landfill should be integrated into the drainage plans for the sports park. This work should be carried out cooperatively by the Company and the City, with the costs shared between them.
4. All future monitoring of surface water quality should include monitoring of surface water flows in any surface waters receiving storm runoff from the Taro operations. All flow monitoring results should be included in the Annual Monitoring Reports.
5. The plans for discharge of stormwater runoff from the East and West Landfills (including all monitoring and contingency plans) should be reviewed by the CLC before any surface water discharges take place.

8.3.9.4 Potential Health Impacts - Particulate

8.3.9.4.1 Recommendations

1. Add fine particulate monitors to the air quality monitoring program. Specifically, PM2.5 monitoring should be included.
2. The design of an appropriate network and approach for air quality monitoring should be developed in consultation with the CLC.
3. Consideration should be given to locating a PM2.5 monitor within the nearby community to demonstrate the differences in dust levels measured at the property boundary of the site and within the community. This monitor could be located in different areas for six month to one year periods to determine particulate levels in specific locations.

8.3.9.5 Dust and Quarrying Operations - MOE

8.3.9.5.1 Recommendation

The responsibilities of the MOE inspector should be modified to include reporting on and assessing the dust impacts of the quarrying operations and road traffic.

8.3.9.6 Particulate Emissions and Operations

8.3.9.6.1 Recommendations

1. The operations manual for the Taro site (including the quarry and roads) should be modified to be more explicit with respect to dust control through on-site watering. Specific attention should be given to visible observation and operator reaction to visible dust emissions.
2. A water cannon should be mounted on the water truck to enable the operator to suppress visible dust emissions on stockpiles and other exposed areas that cannot be reached by the water truck.

8.3.9.7 Heavy metals – Monitoring

8.3.9.7.1 Recommendation

Metals analysis of selected particulate filter samples should be continued by Taro. Selection of filters and target metals to be analysed should be undertaken by the MOE in consultation with the CLC.

8.3.9.8.2 Volatile Organic Compounds (i.e., Gases)

8.3.9.8.2.1 Recommendations

1. VOC monitoring by the Company should be continued annually.
2. The VOC monitoring should include a full (open) analytical scan to identify any changes to VOC emissions. This would be done by performing a full analytical scan and compound identification using a gas chromotagraphy – mass spectrometry analysis. This should be done by a certified laboratory familiar with this type of analysis.

8.3.9.8.3 Odour

8.3.9.8.3.1 Recommendations

1. More detailed procedures on assessing incoming waste (possible odour training of waste assessment staff at the generator and transfer sites).
2. Tighter controls on accepting odorous waste. This would include further training and notification back to the generators and those assessing the incoming wastes, of odorous loads found in trucks or at the site.
3. Use of other covering materials to reduce odour emissions from odorous wastes (e.g. clean soil). The use of temporary covers (e.g. uncontaminated soils) over exposed odorous wastes should be undertaken.
4. Continue to be proactive in attempting to ensure that exposed leachate does not go anaerobic.

5. The CLC should continue to consider odour management to be of ongoing importance and to identify goals/outcome indicators for the odour abatement program.

8.3.9.8.4 Mitigation: Cover Materials

8.3.9.8.4.1 Recommendations

1. Temporary cover should be employed in locations where there is exposed waste, but where activity is not anticipated for 2 or 3 days. The cover should be non-waste material, preferably clean soil. This could be "stripped" back as an area once more becomes active.
2. As well, the staging and operations of the site should be such that any bare areas (waste or cover) should be minimized. Vegetative cover should be established as soon as practical to minimize windblown dust erosion.
3. Clean soils used for cover should not be considered as part of the waste tonnage for the site.

8.3.10 Health Impacts and Implications

The Panel recommends that Schedule "I" be considered equivalent to the Certificate of Approval for monitoring purposes.

The Panel recommends that a comprehensive monitoring protocol be developed by the MOE with input from the CLC and the Company's risk assessment experts. The protocol would serve as a template for reviewing all of the individual monitoring schedules in order to make decisions about adding or removing substances.

This protocol should be reviewed at least annually in light of new information including updates from Health Canada, ATSDR and other relevant parties.

8.3.10.1 Asbestos

The Panel recommends that the on-site inspector should inspect and report, on a regular basis, compliance with the asbestos handling procedures (Regulation 347, Section 17) and the service area. Non-compliance with these procedures should be acted upon immediately.

8.3.10.2 Health Committee

The Panel recommends a process for raising and resolving ongoing health concerns through an adequately supported sub-committee of the CLC.

8.3.10.3 Health Study

The Panel is recommending that a health study program be undertaken in conjunction with other research to permit comparisons with people living in other parts of the Region and country.

8.3.10.4 Ecosystem Health and Integrity

8.3.10.4.4 Recommendation

The Panel further recommends that if the escarpment spring monitoring shows impacts which may be related to the Taro operations or if there is visual evidence of impacts on the health of vegetation near the springs, that a more detailed study of the impacts of the spring discharges on local ecosystem health should be designed (in consultation with the CLC, in particular with the HRCA) and carried out by Taro.

8.3.10.6 Planning Issues

The Panel recommends that the CLC consider whether it wishes to take a more active role in local planning issues related to development around the landfill, including the following:

1. Making a recommendation on whether the City should implement a mechanism to ensure that people who might purchase homes or properties within 1 km of the landfill will be made aware of the presence of the landfill, and of the potential for nuisance impacts as outlined above;
2. Participating in the public input on decisions regarding future developments within 1 km of the landfill;
3. Getting involved in the review of the impact studies done by developers, for development proposals pertaining to areas within 1 km of the site.

8.5 Are Sufficient Funds in Place to Ensure the Long Term Protection of Human Health and the Environment?

8.5.1 Financial Assurances

The Panel recommends that the CLC participate in the next 3-year review process, and that it commission an outside reviewer(costs to be covered by Taro through the CLC budget) to review the financial assurances package to ensure that it is adequate.

In particular, the Panel recommends that any third-party reviewer should carefully evaluate the costs specified for the following issues:

- site closure;
- long-term leachate treatment (cost estimates for this item may be low, given current costs for leachate disposal and treatment);
- long-term site monitoring;

- implementation of post-closure contingency plans.

8.5.2 The Role of the CLC

The Panel recommends that the MOE develop guidelines for the establishment and operation of CLCs.

Accordingly, our recommendation is to increase the ability for the CLC to carry out its vital tasks by adopting the following changes:

a) Expanded membership

The CLC should have additional representation from the HRCA, and a health expert.

b) More Active Role for MOE

The Panel recommends that MOE play a more active role in future CLC meetings, for example by reviewing and commenting on the annual Report; having IEB representatives speak to the CLC on enforcement issues and so on.

c) Health sub committee

The Panel recommends establishment a health sub-committee of the CLC which would be a venue for discussions of ongoing health concerns. This subcommittee is described in the health section.

d) Professional chair/facilitator

The current CLC Chair has faced the impossible task of trying to both chair the meetings and to reflect the concerns of local residents. In its initial phase the CLC had co-chairs (one nominated by the Company, the other by the citizen members) but this arrangement was discontinued after the Company-appointed co-chair moved to a new job.

In order for the CLC to function as a forum for open discussion in which all parties are heard and respected, we recommend the appointment of a neutral chair/facilitator (i.e., someone not associated with any of the parties represented on CLC). Any costs associated with this position should be covered by the Company funded on a similar basis to the full time MOE landfill inspector.

e) Citizens' Coalition

If citizen members of the CLC wish to form a group and/or hold meetings outside of the formal meetings of the CLC to allow members of the community to meet with them and give them input and direction, then modest funding should be provided to cover any costs associated with notice of meeting and room bookings.

f) Staffing from the City

As is the practice with some other CLCs, secretarial support for the CLC and its sub-committees should be provided by the City. In addition to providing a staff person to record the minutes of CLC meetings, the City should also arrange to send out minutes, agenda, and any supporting documentation to CLC members; give public notice of meetings; and make the necessary room arrangements

g) Respect for the Integrity of the CLC Process

The CLC should operate in as open and transparent manner as practicable. Members of the CLC should address their concerns about the matters within their mandate to each other and avoid taking issues to the media or into litigation before allowing for discussion and response from fellow CLC members. Public involvement through questions and answers should follow the guidelines set out in the current CLC Terms of Reference.

h) Focus expands to entire Taro operation (but not other Philip operations)

The current mandate of the CLC is to review the operations of the Taro East Landfill. This mandate should be expanded to include the West Landfill and the East Quarry. Other activities or operations of Philip, unrelated to the Taro sites, do not fall within the CLC mandate and attempts to introduce discussion of such extraneous issues into the business of CLC should be ruled out of order.

i) Consensus decision making

CLC should aim for consensus in all of its decisions, but decide by majority vote when this is not possible. The chair/facilitator chosen should be familiar with the principles and practices of consensus decision making, and should guide CLC members in learning about their responsibilities within such a process. Reasonable efforts should be made to address the valid concerns of all members before reaching decisions.

j) Simplified process for reviewing data and interpreting results

Efforts should be made to ensure that all data and technical reports are presented in clear terms that are comprehensible to non-experts. Data should also be put into context so that the test results for samples taken by different parties are compared.

In future, all independent sampling completed by the MOE of leachate, groundwater, surface water and air quality should be presented to the CLC in a manner that clarifies its relationship to other data. This information should be provided to the Company for inclusion and comment in its annual monitoring report.

k) Reasonable funding for citizen expert consultants to review Annual Report

Funding should be provided to the citizen members of CLC to hire their own technical consultant(s) to review the Annual Report. The selection of specific consultants should ideally be reached through consensus of the entire CLC, but if consensus can not be reached then the choice should be left to the citizen members. Funding required for such consultants will be high in the first year (likely on the order of $20,000), but should decrease after that as the consultants become familiar with the site and as issues get resolved. This funding should not be used for legal services or any other purpose other than technical review and comment.

Funding should only be provided for a given consultant once a work plan and budget has been submitted and approved by CLC. At year's end, proper accounting for the monies spent should be submitted to the CLC by the citizen members.

8.6 Is MOE Up to the Task of Protecting Public Health and the Natural Environment?

The Panel endorses that commitment and recommends that the MOE continue to proceed along these lines. Specifically, this will require the following:

1. Adoption of the "cradle to grave" onus of responsibility on the generator of waste to ensure proper disposal.
2. Review of the delisting procedures and requirements to maximize compatibility between Ontario and regulations in bordering U. S. states.

The Panel also recommends the following:

1. The MOE thoroughly review the requirements regarding financial assurances concerning both remediation or closure of a landfill (in the event of an emergency); and long-term maintenance and monitoring after normal closure of a facility.
2. MOE review sampling procedures for stabilized waste and develop a protocol that allows an assessment of the mixing on a reasonable scale.
3. In future, MOE should present all its independent sampling of waste, leachate, groundwater and air quality should be presented to the CLC in a manner that clarifies its relationship to other data. This information should also be provided to the Company for inclusion and comment in their annual monitoring report.

9.0 Further Lessons from Taro

The Panel recommends that MOE review its practices with respect to the issuing of Certificates of Approval to ensure input from both IEB and field officers with respect to the clarity and enforceability of the conditions contained in these documents.

The Panel recommends that MOE continue its more frequent sampling of leachate, air quality, and incoming waste and report the results of this sampling to the CLC as recommended elsewhere in this Report.

The Panel is of the opinion that provided that adequate resources (i.e., staff time and funding) are made available, that the MOE is able to protect public health and the environment at this and other landfills. The recommendations provided in this report should enable the MOE to better carry out these tasks, and the Panel urges the Minister to implement our recommendations and to make available to the MOE the resources necessary for their implementation.

Appendix D: Comments and Recommendations related to the Design and Operations of the East Landfill

1. It is recommended that the issue of how and where the water will be introduced be addressed in more detail with particular attention to minimizing the aeration of the water during its introduction and expelling air from the system during saturation.

2. It is recommended that Taro's consultants consider installing one, or even two, back-up (redundant) pumping stations at some distance from the proposed pumping station. These could be used to control the leachate head in the event that, in the long term, there was clogging around the existing pumping station.
3. It is recommended that Taro's consultants consider sealing Pumping Well M4 like the others within the footprint and if a contingency well is needed, consider constructing one outside the landfill foot print.
4. It is recommended that Phase 1B be completed and the final cover placed in this area as soon as practicable in an effort to minimize dust from the landfill and to improve its appearance.
5. It is recommended that (a) testing be conducted to ensure that the geomembrane meets the requirements of Ont. Reg. 232/98, Schedule 3, Clause 1.2 and 1.3 (there is a reasonable probability that the geomembrane material that has been used does meet this requirement but it would be useful to confirm this in future); and (b) a more robust protection layer be used above the geomembrane.
6. It is recommended that the lift thickness be reduced to 150mm in association with the use of the CAT815 compactor for all but the first liner lift (which should be thicker than 200mm to protect the underlying geotextile) to minimize potential problems and further enhance public confidence in the liner.
7. It is recommended that the data on leachate levels in the leachate collection system and water levels in the hydraulic control layer (HCL) be more clearly reported in a single table for all monitors in the East Landfill. Also the chemistry in the HCL should be monitored and clearly reported.

Appendix E: The Ecosafe Process

The Panel recommends that the Company and the MOE further assess the suitability of the current mixing procedures (which involve the use of a front-end loader) as part of the review of the EcoSafe process.

Appendix F: Analytical Methods

The Panel recommends that the Ministry of the Environment undertake a limited mass spectrometric study of the leachate from the Taro landfill and from 3 other industrial waste facilities for comparison. Leachate samples and emitted gas samples (cartridge) should be analysed by open scan mass spectrometry at high sensitivity.